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ABSTRACT

This document is a packet of instructional materials for training secretaries and clerks for the petroleum, mining, and solar energy fields. Developed by Eastern New Mexico University and the New Mexico State Department of Vocational Education, and aimed at New Mexico industry, the curriculum is divided into three units of petroleum, mining, and solar energy secretarial occupations. Each of these divisions contains background information about the industry, information about reports used by that industry with which the secretary may need to work, and a working vocabulary with definitions. Specific occupations covered are land and legal secretary, geologist's secretary, oil company production secretary, and solar energy research secretary. (KC)

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# CURRICULUM FOR

# PETROLEUM, MINING AND SOLAR ENERGY

# SECRETARIES

**Curriculum Development (Sec. 133)**

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**Oil Industry, Solar Energy Industry, and Mining Office Occupations.**

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**Organization:** Eastern New Mexico Univ., Roswell. Dept. of Business and Office Education

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Curriculum packets will be developed to provide students with a working knowledge of the spelling, vocabulary, and instruments unique to oil, mining, and solar energy office occupations. The curriculum will contain a concise introduction to and explanation of each area.

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Eastern New Mexico University--Roswell Campus
In cooperation with the Department of
Vocational Education
June 30, 1978

CE 028 332

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Sandia Laboratories, Albuquerque, New Mexico

LAND AND LEGAL SECRETARY

## LAND AND LEGAL SECRETARY

In any oil and gas operation, the basis of any transaction is land.

All the land in the United States of America belongs to someone--either to the U.S., the state in which it is located, to one or more individuals, to a corporation or other kind of company or charitable organization, to an Indian tribe, etc. The owner of the land has the right to say who shall go on that land and conduct mining operations or explore for oil and gas.

When an oil operator wishes to obtain the right to go on someone's land to explore for oil or gas, he employs an individual known as a landman. The landman negotiates an oil and gas lease, which is a legal document granting to the oil operator the right to explore for oil or gas in return for certain remuneration or benefits. The remuneration usually is paid in more than one way: when the lease is first taken, the landowner receives a "bonus" of a certain amount of money per acre. This bonus holds the lease for a period of one year. After that year has expired, the lease may then be held by production ("HBP" in oil talk), if, in the meantime, a well has been drilled which was capable of producing oil and/or gas in paying quantities.

If the lease has not been drilled, it may still be held by payment of "annual delay rentals." These rentals must be paid each year on the anniversary of the lease in order to hold the lease until its term expires, unless production is found.

Once production is found, the landowner then gets another kind of remuneration, called "royalty." The word "royalty" comes from English law, and originally referred to lands belonging to the king, or the "king's part" of income derived from the use of lands belonging to the crown. In this country, it means the part of the income belonging to the landowner. In the case of oil or gas, it is the portion of the income reserved to the landowner, and it is "off the top," meaning it is his share of 100%. Furthermore, it is his without any cost to him of exploring, drilling, producing, or transporting the oil or gas.

Kinds of Lands

As mentioned above, there are many kinds of ownership of land; however, they fall into three major categories, and are the three kinds you will encounter in New Mexico. They are federal (U.S.A.), State of New Mexico, and fee lands. Fee lands are those held by individuals, companies, or private (non-governmental) institutions, etc. The word "fee" also comes from old English law, and refers to absolute, legal ownership of land, with the right to sell, lease,

bequeath, mortgage, or otherwise convey the land in any way the owner chooses.

Federal. In many states, particularly in the West, the federal government owns a great deal of land, and this ownership includes the rights to the minerals under the lands, including oil and gas. Federal lands are administered by the Bureau of Land Management, which is a part of the U.S. Department of the Interior. The "BLM" has an office in Roswell which administers rangelands, etc., but the Santa Fe office is the one that handles oil and gas leasing.

There are several ways to acquire oil and gas leases from the BLM, but the best known one is by entering the monthly simultaneous filings, or drawings, which is actually a lottery of sorts. (Exhibit "A1")

In order to enter this "lottery", the oil man (or any U.S. citizen, for that matter) submits a simultaneous filing card (see Exhibit "A"), properly filled out, along with $10 filing fee for each card. He can enter only one card for each tract desired. Incidentally, in order to find out which tracts are available, he will either be on the mailing list from the BLM, or subscribe to a service of some kind which furnishes him with the monthly list of parcels of land which are being offered each month. At the time the drawing is held, all the cards for each tract are put into a "hopper" and a card is drawn. The person who submitted that card then is the "winner" of the right to become the owner of a federal oil

and gas lease by paying the first year's annual delay rentals within 15 days. The rentals usually amount to $1.00 per acre. Therefore, if you were to submit a filing card and you were the winner of, say, a tract containing 320 acres, it would cost you $10 for the filing fee and $320 for the first year's rentals, or a total of #320. The leases are generally for a term of ten years.

Attached as Exhibit "B" is a federal oil and gas lease, a rental receipt for the first year's rentals, and Exhibit "C" an "Assignment affecting Record Title." The latter refers to the means by which title to an oil and gas lease is passed on to a third party. Rentals on federal leases were 50¢ an acre until February of 1977.

Let's stop here and define some important words.

Lessor - This term refers to the landowner who has granted an oil and gas lease.

Lessee - This is the party who acquires the oil and gas lease from the lessor.

Assignor - Once the Lessee acquires the lease, the lease may change hands several times; however, if the lessee then conveys the lease to another party, the lessee becomes an "Assignor" - because he "assigns" the lease to another party. The party who receives the assignment becomes an "Assignee."

Assignee - An individual or company who acquires an assignment from an "Assignor."

Assignment - A legal instrument which conveys title to the oil and gas rights. (The word "assignment" can also refer to an instrument conveying real estate, etc., but we will confine it here to record title of

oil and gas rights). Note: There may be several assignments of the same oil and gas record title, but only one lease.

Record Title - The title (or "right") to real estate or oil and gas rights (here we are referring to the right to explore for oil and gas, such as an oil and gas lease) which is "of record" in the proper governmental agency. This agency may be the county clerk's office, the State Land Office, or the BLM.

State Lands. Lands owned by the State of New Mexico are administered by the Commissioner of Public Lands in Santa Fe. This office is generally referred to as the "State Land Office." One of the several ways to acquire leases on state lands is to submit bids at the monthly "State Sale." At this sale, an oil operator will submit either a written, sealed bid, accompanied by a check or money order for the amount of his bid, plus a $10 filing fee, or he will appear in person at the "oral bidding" which is an actual auction. In either case, the individual or company submitting the highest bid will acquire the tract upon which he bids. He then receives an oil and gas lease for a term of ten years (some state leases are for only five years), but, unlike the federal leases, he does not have to pay any rentals the first year. Rentals on state lands are cheaper--usually 50¢ per acre, or even 25¢ per acre.

Fee Lands. As we mentioned previously, these are private lands owned either by individuals, private companies, or private institutions, etc. Because ownership of fee land is

not as clear-cut, usually, as lands owned by the government, it is often necessary to determine who the owners actually are, and whether or not the land is free and clear. For this reason, the landman may first go to the county court house and check the records in the office of the county clerk. He may then offer to purchase an oil and gas lease from the landowner, who will try to get the best deal he can in the way of bonus and royalty.

The average oil and gas lease is for a term of five years. Just a few years ago, it was usually for ten years. Nowadays, many shrewd lessors are negotiating for three-year or two-year leases, or even less, if it is in a "hot" area. The standard royalty used to be 1/8 (which is 12-1/2%). Today, a 3/16 royalty is common, and a tough trader may get considerably more. Annual delay rentals are usually for $1.00 per net acre, but once in a while you see $2.00, or even $2.50. The reason shrewd traders want shorter term leases is to force the oil operators to drill upon the property to hold the lease, rather than holding it by payment of rentals.

Landman. The landman is a very busy person. He does a great deal more than just buying leases. He handles all the land work involved in drilling wells, negotiating "farmouts", and various kinds of contracts. He often writes simpler contracts and various kinds of legal instruments himself, and does a lot of title curing that does not necessitate the use of an attorney. Most oil operators are familiar to some

degree with land work. Many of them are landmen themselves, either by formal training, or by picking it up along the way. The duties of the landman are so varied that we can only spend a little time discussing it here. However, you may be interested to learn that many women are now going into this field. A few years ago, a woman was a rarity in land-work, but no longer. If you work very, very hard and are willing to learn your job and more, you can aim for the job of a landman!

WHAT PART DOES THE OIL AND GAS ATTORNEY PLAY?

Many people think of attorneys are being like Perry Mason--always defending someone in court against criminal charges of some kind, or else suing some malefactor on behalf of a wronged client. Attorneys, however, specialize just like doctors, and there are lawyers who specialize in corporate law, tax law, insurance law, etc. The ones we deal with in the oil business are specialists in oil and gas law. An oil and gas attorney may attend hearings held by various government agencies, but he seldom appears in a regular court case. When he does appear, it will be in a civil action concerning title problems.

Many times a company will have an attorney examine title before an oil and gas lease is purchased, especially if a large sum is involved, or if there are obvious title problems. The attorney will usually begin by ordering abstracts of title from an abstract company who specializes in obtaining copies of legal instruments from the public records (county, state, or federal). The abstract represents a kind of "history" of the land from the time the first owner obtains title to the land on down to the present day. By looking over these abstracts, the lawyer can see all the different legal transactions that have taken place concerning the land--the conveyances, liens, etc., that affect record title. The lawyer will then prepare a "title opinion" as to the validity of the record title. He may "approve" title right then, or he may suggest certain

"curative" measures that need to be taken in order to make the title "marketable."

Later on, when the oil operator decides to drill a well upon the lands covered by the lease, he may have his attorney prepare another kind of opinion, called a "drilling title opinion," or a "drillsite title opinion." He will surely do this if he didn't have the title examined when he first took the lease, because he will be expending vast sums to money to drill a well, and he wants to be sure he has a bona fide lease. Here again, the lawyer will furnish the oil operator with his title opinion, and it may contain certain "requirements" that must be satisfied in order to make the title satisfactory for drilling purposes.

After the well is drilled, and when production is (hopefully) found, the attorney will then prepare a division order title opinion, which will set out the names and interests of everyone who has a share of the income from the well due him, as well as the type of interest each person owns (royalty interest, working interest, overriding royalty interest, etc.).

Many hours are spent by oil and gas attorneys various types of legal instruments. These instruments include conveyances of several kinds, affidavits, quit claims deeds, stipulations of interest, releases, several kinds of contracts, and many more. He may have to examine probate proceedings to determine who inherited some deceased person's property, advise the oil operator concerning trusts, guardianships, etc., and numerous other duties.

LAND SUPPORT PERSONNEL

This is the term currently used to describe the various persons who work in large land departments. In a major oil company, Land Support Personnel might include secretaries, lease record clerks, rental clerks, division order clerks, title clerks, contract clerks, draftsmen, and others. In a small, independent oil operator's office, one person often does it all. She may also be the production clerk, bookkeeper, file clerk, and take drilling reports. In fact, if you work in Roswell for an oil operator, the chances are that you will perform several of these duties. Some of these duties include:

1. Secretary. As a secretary, you will take dictation, type letters, leases, and any other legal instruments as needed. You will maintain correspondence files, answer telephones, take messages, handle reservations, greet visitors, open mail, and see that the office runs efficiently and smoothly. Your instructor has already stressed the necessity for being neat, clean, punctual, courteous, and reliable. The very best asset you can have in your role as a secretary is a good attitude.

2. Lease Record Clerk. Duties of a lease record clerk include checking over leases and related instruments to see that they are properly signed, acknowledged, and recorded in the proper governmental office, setting up lease files, and noting any special requirements of the lease. You will be

careful to keep your files up to date, noting any changes in ownership or status of the lease.

3. Rental Clerk. You will be responsible for timely payment of annual delay rentals and, possibly, shut-in gas royalty payments. You will maintain a time file by month for the purpose of paying rentals at the proper time, and you will make sure the rental checks are received by the proper parties, and that you have a receipt in the files for each rental paid.

4. Division Order Clerk. You will check each division order received to be sure the interests of your employer are properly represented in the division order. If your company is the disbursing party, you may have to prepare division orders yourself, and figure out the proper percentages of interest each party owns.

It is not likely you will be faced with the duties of title or contract clerks in Roswell, as these are found in major companies, these duties are handled by landmen.

5. Draftsman (Draftsperson). Land Department drafting is much different from the technical kind done for engineers, architects, etc., and a great deal easier. Land drafting consists of posting leases to land ownership maps, and may also include posting wells to maps. The two main requirements (besides good eyesight) are the ability to print neatly (and very small), and the ability to read ownership maps so that the information will be posted in the right place.

HOW TO READ MAPS

## USE OF MAPS IN DETERMING LOCATION AND OWNERSHIPS AND HOW LAND IS SUBDIVIDED WITH AN EXPLANATION OF THE LAND DESCRIPTIONS USED

One of the most important, if not the most important tool of the landman is the maps which he uses in establishing the location of land and the ownership of that land. Any map is essentially a graphic drawing of a portion of the earth's surface. To this the lines of latitude and longitude and the position of the physical features are added. To this physical map the ownership, both surface and mineral is added, making our map a useable tool as to who owns what and where it is located.

The authority for the construction of maps in our country, known as the rectangular system of surveying, is based upon various acts of Congress, beginning as early as 1785, which will not be discussed in this introduction for lack of time. However, there are certain points that are necessary to be brought up in order to show the construction of the maps and the application of the ownership.

The rectangular system of surveying has been used in all of the United States except the original 13 states and the state of Texas, - - - and it should be mentioned here that for the most part, the surveys of land in the original 13 states and Texas are by metes and bounds. By metes and bounds it is meant that the exterior boundaries are determined by lines which have been surveyed from a known point or points. The tracts are usually irregular in shape.

The basic rule of any land survey is that three elements of a triangle be determined from whence the area encompassed can be determined and the location fixed. It is interesting to note that the state of Texas was surveyed by a series of railroad surveys, all of which were not on a uniform basis. Some were on a square mile basis and some were made from old Spanish systems of varas, leagues and labours. This type of irregular surveys naturally did not join perfectly and it is from this system of surveying that our famous "vacancies" resulted, such as Fred Turner's vacancy strip in the Yates pool in Pecos County, Texas, and Ed Landreth's vacancy strip in the Church and Fields pool in Crane County, Texas.

Congress establishes what is known as the township basis of surveying. However, in order to determine the location of the township on the ground, it became necessary that control axes be determined. In order to effectively discuss the control axes necessary for the location of our surveys in New Mexico, we should at this point consider how these control axes are determined.

There have been several large surveys made in some of the adjoining states. A portion of Colorado is part of one of these larger surveys. At the beginning of the survey work in the western part of our country, surveying began starting at the Missouri River and was surveyed westward. The base lines and meridians thus surveyed succeeded in bringing the base lines and meridians up to the east front of the Rocky Mountains in Colorado, which state, of course,

borders New Mexico on the north. There are approximately 32 control axes (meridians & base lines) used by surveyors in the U.S. However, it is not necessary to discuss all of these and for our starting point let us take as an example the location of our control meridian and base line in the State of New Mexico. (See Figure 1 and 1A).

The initial cause for surveying in New Mexico was brought about due to the mining industry centering in and around Socorro, New Mexico. Here it became necessary to tie in the location of the many mining claims which caused an immediate need for the location of a common point from which to begin this survey. This common point, called a monument, for the surveys in New Mexico, was located approximately 14 miles north of the town of Socorro, at a little town called San Acacia. (See Figure 1).

From this starting point a line is run in a true north and south direction which is called a principal meridian. Also, from this point is run a direct east and west line called a base line. It is at the intersection of this base line and meridian line that our monument is located.

Due to the durvature of the earth other meridians are run, usually every 24 miles east and west of the principal meridians. These are called guide meridians. Other lines called parallels are run, usually every 24 miles north and south of the base line; however, in this New Mexico survey of ours, the parallels were run every 30 miles.

Lines are then run north and south parallel with the principal meridian and six miles apart which are called ranges. Similar lines are then run every six miles north and south of the base line. These lines are called township lines. This results in cutting the base lines and meridians into six mile squares which are called townships. (See Figure 1A).

Thereafter, the resulting townships are subdivided into 36 tracts as near to one mile square as possible containing approximately 640 acres each. These tracts are called sections and are numbered from 1 to 36 beginning in the NE corner and going west and east alternately throughout the entire township. (See Figure 2).

The 640 acre section is the smallest tract required to be surveyed by law. However, further subdivisions are made by dividing the section into four quarters which contain 160 acres more or less. These are called northeast quarter, northwest quarter, southeast quarter and southwest quarter. however, due to the curvature of the earth and unavoidable errors, some of the sections along the north and west boundaries of certain townships are irregular. Therefore, the sections along the north and west boundaries of these particular townships must take up any excess or shortage of acreage in the township.

These "Boundary" sections are further reduced into quarter-quarter sections, called lots. (See Figure 3). It is in these lots that the excess or shortage of acreage is made up.

In describing the fractional parts of a section, (See Figure 3A), the legal description can be properly shown as NE/4, NW/4, SE/4 and SW/4. These quarter sections can further be reduced by dividing each quarter section into halves, quarters, etc. For example, a quarter section can be subdivided into the N/2 and S/2 such as the N/2 of the NW/4 or it can further be subdivided such as the W 3/4 of the S/2 of the NW/4. Other subdivisions can be made such as dividing the SW/4 into the W/2 of the SW/4, W 1/4 of E/2 of SW/4 and E 3/4 of E/2 of SW/4 and so on in any manner that is desired to further reduce the section. Read description backwards.

Any and all of these fractional parts of a normal section contain a given amount of acreage unless otherwise noted. For example, a normal section contains 640 acres, a half section contains 320 acres, a quarter section contains 160 acres, etc.

For your information and convenience, a table is given below showing some of the measurements that we have discussed.

| | | |
|---|---|---|
| 1 Township | = | 6 miles square = 23,040 acres |
| 1 Township | = | 36 square miles = 23,040 acres |
| 1 Acre | = | 43,560 square feet. An acre = any rectangular tract, the product of the length and width of which equals 43,560 square feet. |

Determining Location of Land and Ownership (See Figure 4)

In order now to determine a given location and learn how this location was determined, let us select the City of Roswell, New Mexico, and vicinity, as our specific example.

The New Mexico Principal Meridian is one part of our axes and the base line is the other part of our axes.

Roswell, New Mexico, lies in T-10-S, R-24-E, which means that Roswell is 60 miles south of the base line and 140 miles east of the New Mexico principal meridian. Of course, by referring to a map we can locate T-10-S, R-24-E and from there be able to locate any of the sections therein. The range number in which the land is located is placed about in the middle of the township and range and as you have seen, the section numbers are usually in the centers of the sections. (See Figure 4). A map that is properly made will provide the legal description of over 90% of the tracts in which the land or ownership is to be determined, there being very few areas in the U.S. today for which there is no commercial map available.

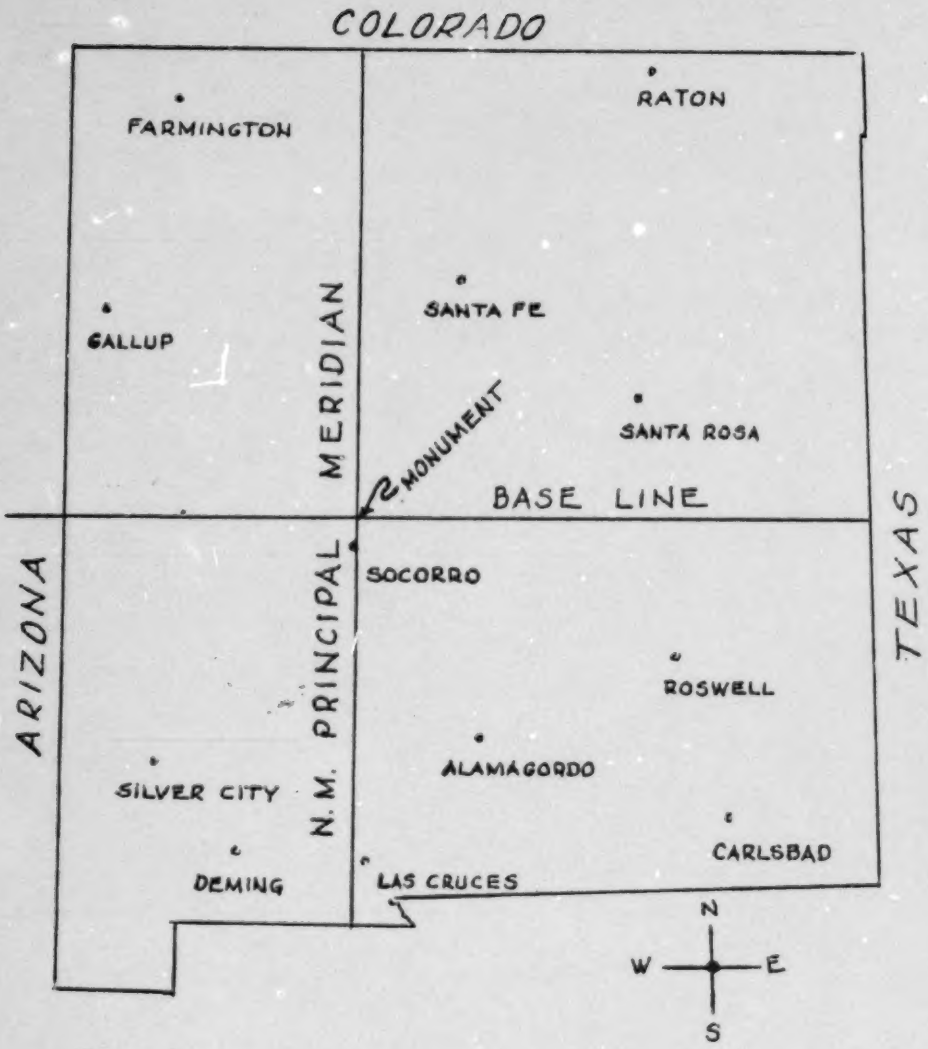



Fig. 1

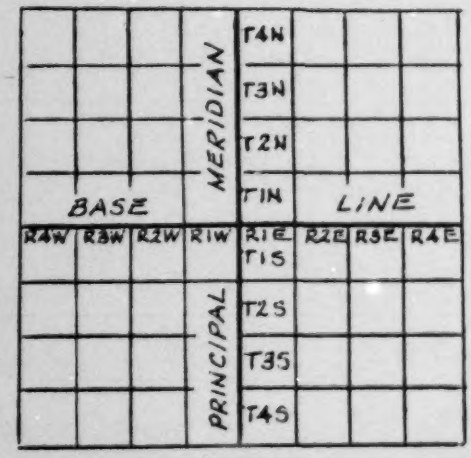



Fig. 1-A. PLAN OF NUMBERING TOWNSHIPS FROM MERIDIANS & BASE LINES.

| | | | | | |
|---|---|---|---|---|---|
| 6 | 5 | 4 | 3 | 2 | 1 |
| 7 | 8 | 9 | 10 | 11 | 12 |
| 18 | 17 | 16 | 15 | 14 | 13 |
| 19 | 20 | 21 | 22 | 23 | 24 |
| 30 | 29 | 28 | 27 | 26 | 25 |
| 31 | 32 | 33 | 34 | 35 | 36 |

Fig 2. PLAN OF NUMBERING SECTIONS IN A TOWNSHIP

C. 23

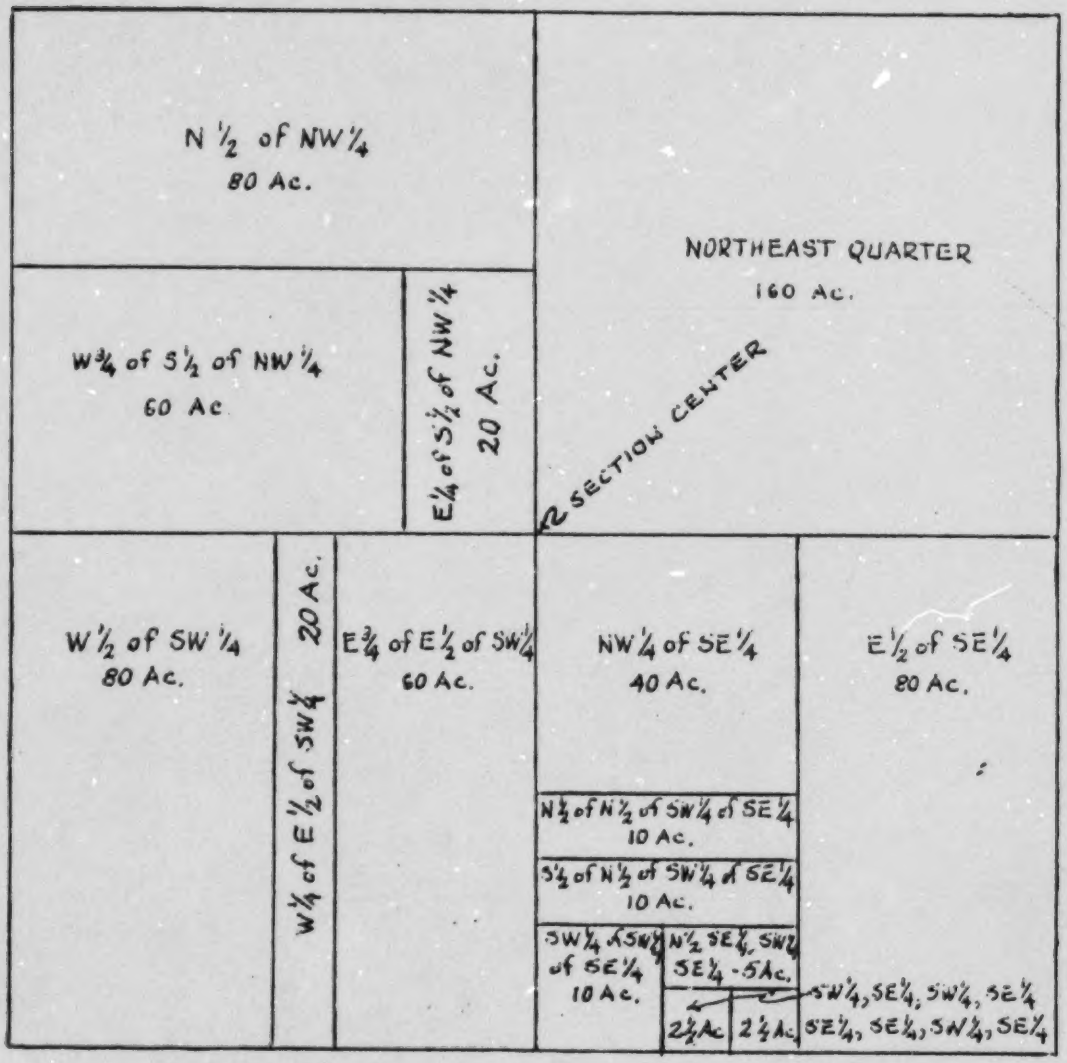



Fig. 3-A ACREAGE & DESCRIPTION OF FRACTIONAL PARTS OF A SECTION.

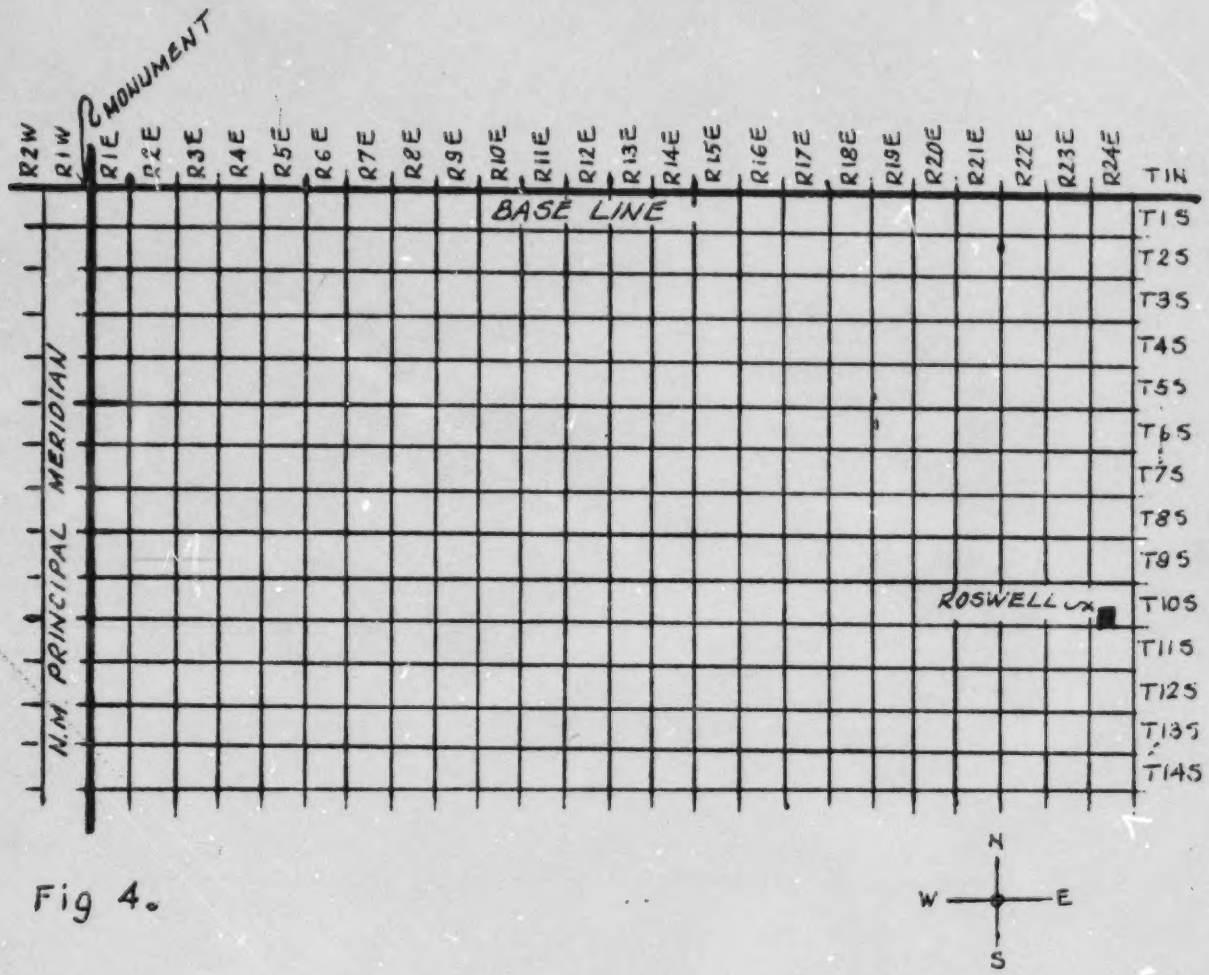
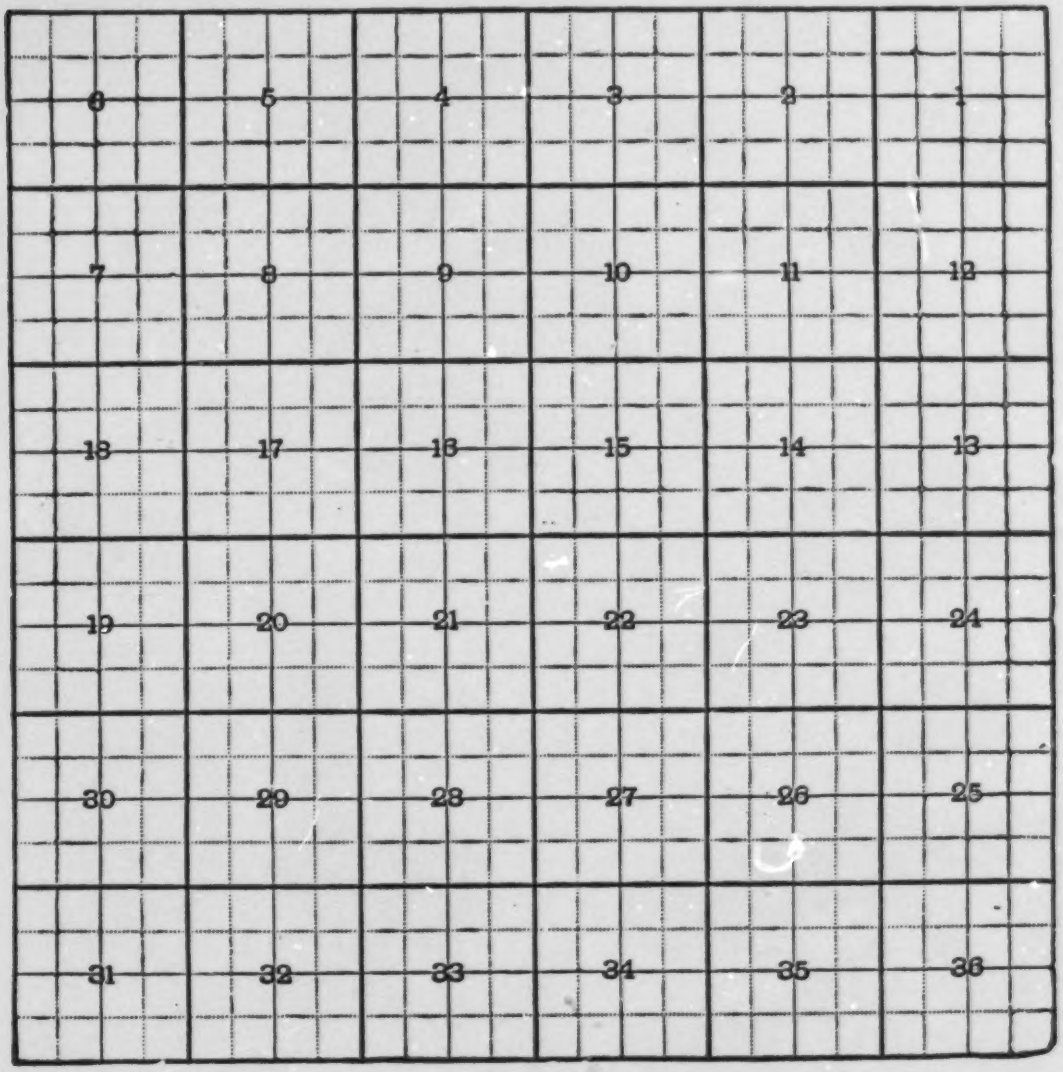

R2W
R1W
MONUMENT
R1E
R2E
R3E
R4E
R5E
R6E
R7E
R8E
R9E
R10E
R11E
R12E
R13E
R14E
R15E
R16E
R17E
R18E
R19E
R20E
R21E
R22E
R23E
R24E
TIN
BASE LINE
N.M. PRINCIPAL MERIDIAN
T1S
T2S
T3S
T4S
T5S
T6S
T7S
T8S
T9S
ROSWELL
T10S
T11S
T12S
T13S
T14S
N
W
E
S

Fig 4.

Example - this is called a township plat, and shows one complete township. If you called this Township 10 South, Range 25 East, it would include part of Bitter Lakes.

_____ County _____

Sec._____ Township No._____ Range_____ or New Mexico Principal Meridian




**Scale: 1 inch = 1 mile.**

Notice the sections are numbered in a "zig-zag" pattern. They are divided by the solid lines into quarter-sections, then further divided by the dotted lines into quarter-quarter-sections.

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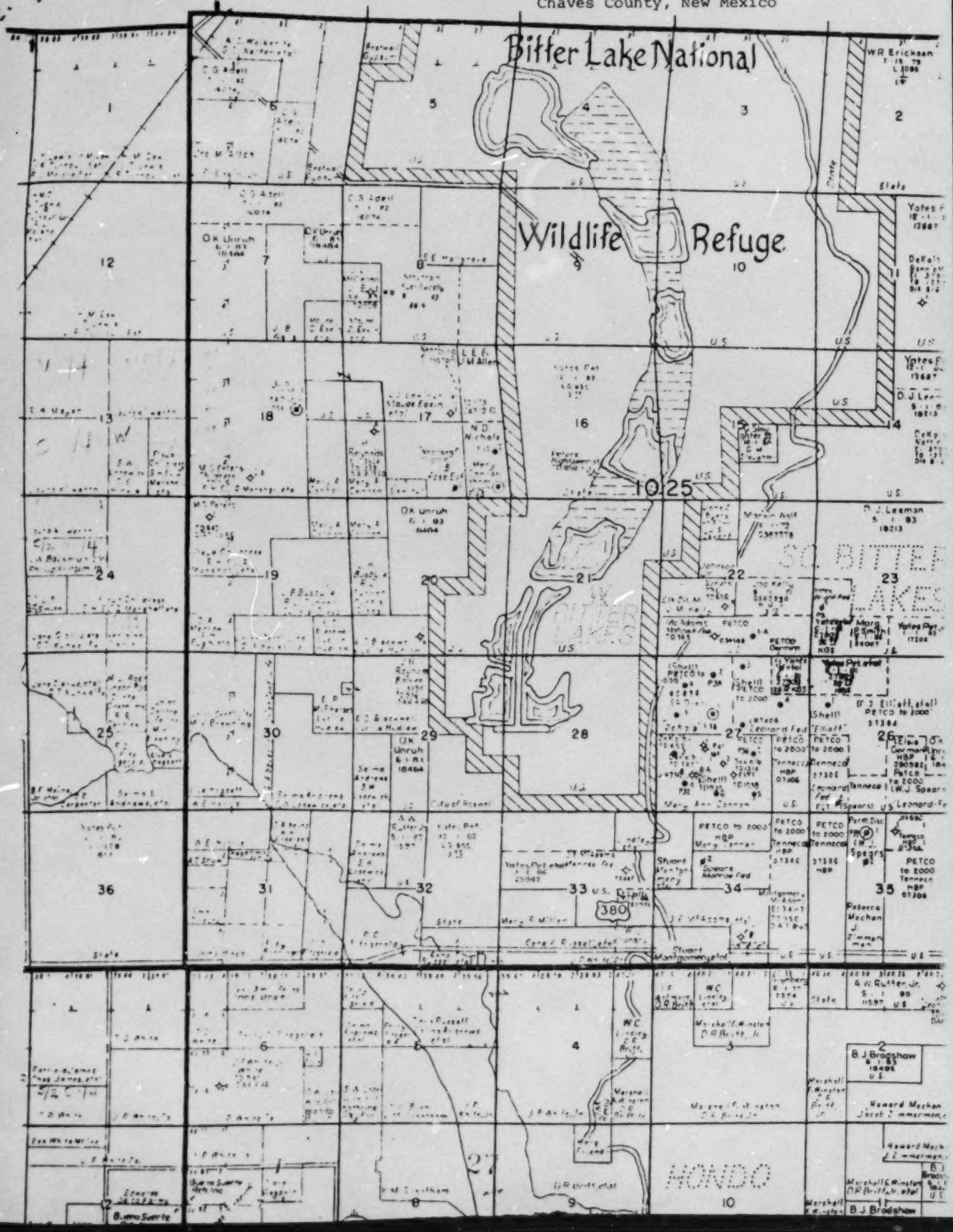
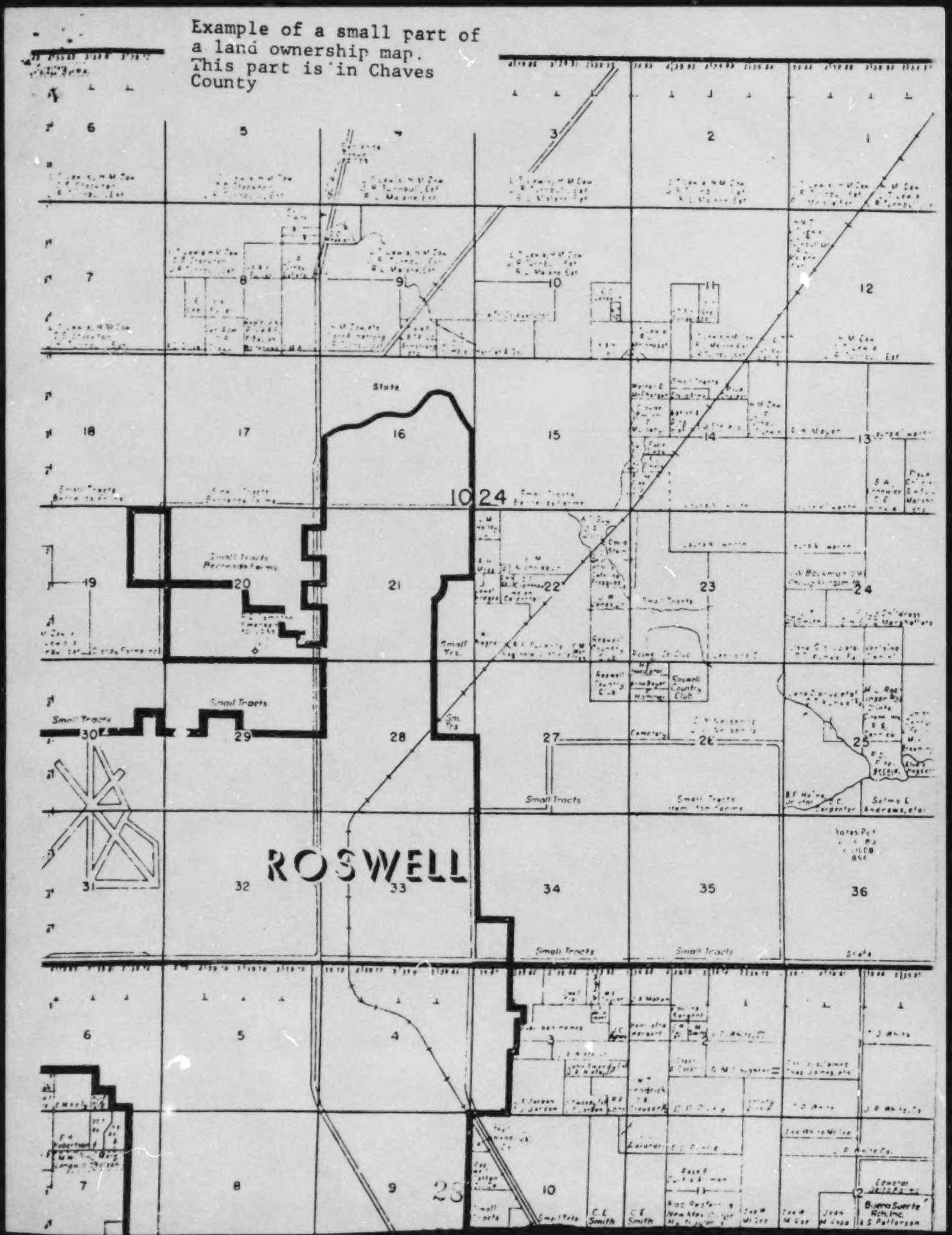
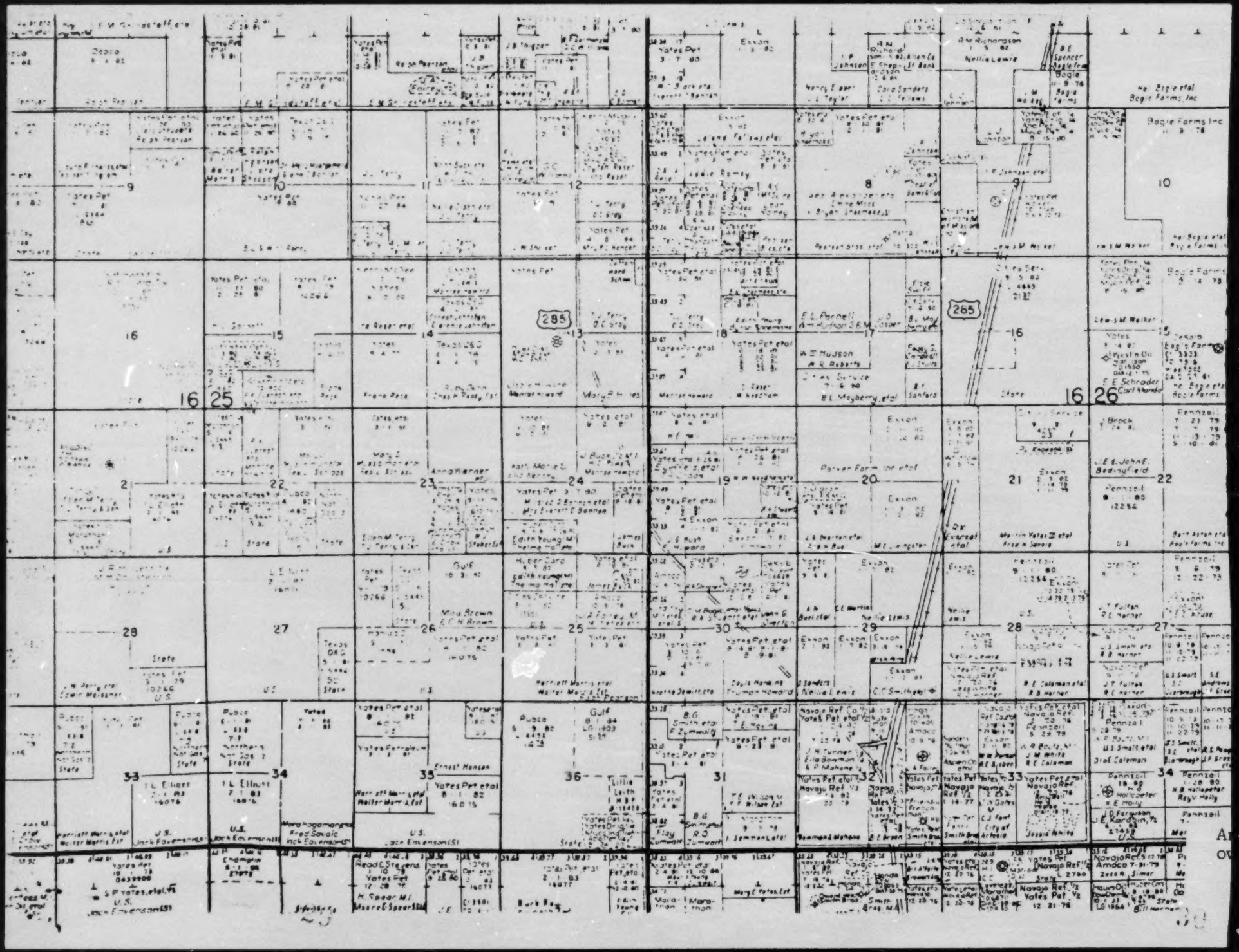
Portion of a land ownership map -
Chaves County, New Mexico




Example of a small part of a land ownership map. This part is in Chaves County
ROSWELL
State
Small Tracts
Cosmelli Country Club
Small Tracts Recreational Farms
Small Tracts
Small Tracts
Small Tracts



LAND AND LEGAL SECRETARY

Vocabulary

Abstract of title: A summary of the ownership history of a piece of real property.

Acknowledge, acknowledgment: A statement signed by a notary public and attached to a document that says that the person who executed the document stated to the notary that he is the person who signed the document and that he did so of his own free will.

Acreage, acreage contribution, acres: area in acres.

Affidavit: A formal statement made in writing, the truth of which is sworn to before a notary. It is signed by both the maker and the notary.

Assign, assignee, assignment, assignor: Those entitled to receive property. Grantees under a conveyance.

Attorney (at Law): A person who is licensed to practice law in the courts of a state.

Attorney-in-fact: One who is empowered to sign legal documents and make legal contracts for another. One who holds another's power or attorney.

Bonus: A sum of money in addition to interest or royalties charged for the granting of a loan or privilege to a company of for the lease or transfer of property.

Bottom hole contribution: A contract for the payment of money or other considerations upon the completion of a well to a specified depth.

Clause: A distinct article in a formal document.

Communize, communication (agreement): To make into. To join leases together to make a propration unit.

Contract: An agreement, legally binding, between two or more parties. Contracts must have a grantor, a grantee, some kind of "consideration", i.e., money, or other valuables, and the parties must be legally able to make a contract (not be minors, etc.) Also, the contract must not be in violation of any laws. Sometimes "consideration" may be the performance of some kind of service, rather than money.

Cure, curative: Refers to legal remedies necessary to perfect a title to property.

Deed: An instrument used in the transfer of title usually for real property, or for mineral interests under real property.

Delay rentals: A payment, usually made annually, in lieu of drilling to keep a lease valid.

Description (Land description, legal description, lease description--all mean the same thing): A detailed identification of a tract or parcel of land as described in a legal instrument such as mortgage, lease, or deed.

Disclaimer: A denial or disavowal of legal claim.

Division Orders: Legal instruments setting out the division of ownership of oil or gas production, e.g., working interests, royalty interests, overriding royalties, production payments, etc., and the amounts.

Document: A legal instrument, i.e., a deed, will, lease, contract, assignment, mortgage, etc.

Dry hole contribution (or dry hole money): Contribution paid for well that does not produce oil, gas, or water in commercial quantities.

Farm-in: To receive a lease from another party with the provision that the person reciving the farmed in lease will drill same. The person or company granting the farm-in will usually reserve an overriding royalty. This way he receives income without any cost of drilling and producing the well.

Farm out (Also: Farm out contribution, farm out contract, farm out letter, etc.): To turn over for performance or use on contract. (See above)

Fee (as in fee lands, fee lease): Absolute, legal ownership of land, with the right to sell, lease, bequeath, mortgage, or otherwise convey the land in any way the owner chooses.

Field: A geographical area in which a number of oil or gas wells produce from a continuous reservoir. The term generally refers to the surface area, although at times it may refer to both the surface and the

underground productive formations. In a single field there may be several separate reservoirs at varying depths.

Guardian: A person entrusted by law with the care or property of another person.

HBP: Held by production.

Heir, heirship: Those who receive bequests through a will.

Instrument: Any legal document.

Join, joinder: A bringing together of parties as plaintiffs or defendents in a suit or as signatory parties to an agreement.

Jurat: A certificate added to an affidavit stating when, before whom, and where it was made.

Jurisdiction: The power, right, or authority to interpret and apply the law.

KGS: Known Geologic Structure - this refers to a certain kind of federal lease.

Land, lands, landman: A portion of the earth's solid surface distinguishable by boundaries or ownership. Land description is a detailed identification of a tract or parcel of land as described in a legal instrument such as a mortgage, lease, deed.

Lease, lease description, lease broker: A legal document executed between the landowner or lessor and another party as lessee that grants the right to exploit the premises for minerals or other products. Also, the lease is the place on which producing wells, stock tanks, separators, LACT units, and other production equipment are located. Lease broker - an independent landman who deals in oil and gas leases.

Leasehold: A tenure of a lease. Property held by lease.

Lessee: This is the party who acquires the oil and gas lease from the lessor.

Lessor: This term refers to the landowner who has granted an oil and gas lease.

Lot, lots: Refers to a legal subdivision containing either slightly more or slightly less than 40 acres. Also

refers to tracts for homesites, etc., in municipalities. (town lots)

Operator: The person or company, whether proprietor or lessee, actually operating an oil well or lease.

Operating Rights: Has the authority to operate on a lease.

Operating Agreement: The document that gives an operator the right to a lease.

Option Farmout, option farmout contract: The right to drill on a leaseholder's acreage provided certain requirements have been met--usually the drilling of a well on adjacent acreage.

Override, overriding royalty: A cost-free interest in a lease equal to a certain percentage of the proceeds. This interest in non-participating and has no signatory rights.

Participate, participating, participation: To have a part or share in something, particularly in a well and/or a lease including the costs as well as the proceeds.

Partner, partnership: An agreement between two or more persons who unite their labor, skill, and capital for the purpose of conducting a lawful business and making a joint profit.

Patent: A grant of land from the government - the original conveyance from sovereignty. Later conveyances are called deeds.

Pool, pooling: Pool can refer to an oil or gas field or to the combining of leases to make a spacing unit large enough to satisfy government regulations.

Power of Attorney: A written instrument which gives a person the authority to act on behalf of another person in a specific incident or to act continuously in this capacity.

Primary term (of lease): First part of term of the lease. Leases are written for specified periods called terms. Term can be extended various ways, such as by production or by drilling. State of NM leases can be extended five additional years (primary term is five years) by doubling the amount of annual delay rentals. The lease is then in its secondary term.

Produce, production: That phase of the petroleum industry that has to do with bringing the well fluids to the surface and separating them and with storing, gauging, and otherwise preparing the product for the pipeline; The amount of oil or gas produced in a given period.

Pro forma: Made or carried out as a formality. Refers to something done legally for form's sake.

Pro rata, proration, proration unit: Proportionately according to an exactly calculable factor (as share or liability). Proration units are certain spacing areas set by governmental regulation in order to prevent drainage of adjoining leases by oil or gas wells.

Range: One of the north-south rows of a township in a U.S. public-land survey that are numbered east and west from the principal meridian of the survey.

Ratify, ratification: To approve and sanction formally.

Recording, recordation, record: Filing or entering in the public records of governmental agencies such as county or state (county clerk, etc.)

Record Title: Title to land or minerals as shown on the public records.

Rental, rentals: An amount paid or collected to hold a lease force in lieu of drilling. Also called delay rentals.

Rental Division Order: An instrument setting out the amount of delay rentals due the lessors where more than one persons owns interests in the same land.

Revenue Interest: Net interest after royalties, overriding royalties, and other working interests are deducted.

Royalty: A share of the product or profit reserved by the grantor esp. of an oil or mining lease.

Secondary term (of lease): Immediately derived from something original, primary, or basic. (See primary term)

Section: A piece of land one square mile in area forming one of the 36 subdivisions of a township.

Shut-in, shut-in gas payment, shut-in royalty: To close the valves on a well so that it stops producing; said of a well on which the valves are closed. Refers

primarily to gas wells. Most leases require operators to pay shut-in payments in lieu of rental or royalty when wells are shut-in for longer than certain periods, say, 60 days.

Spacing, spacing unit: The regulation of the number and location of wells over a reservoir as a conservation measure.

Stipulation: A condition, requirement, or item specified in a legal instrument.

Supplemental abstract (of title); supplemental title opinion: Bringing the history of the land up-to-date from the county and/or state (or federal) records.

Support, support letter: Contributions in the form of acreage or money as inducement for an operator to drill a well. Money can be "dry hole contribution" or "bottom hole contribution," etc. Acreage can be option farmout, etc.

Title, title opinion: Legal ownership of property, especially real property.

Township: A division of territory in surveys of U.S. public land containing 36 sections or 36 square miles.

Tract: A defined area of land.

Unit, unitization, unitize: Joining several leases for continuous development of an area with one operator representing all owners.

Unit operating agreement: An agreement governing the development and producing operations in an oil field in which several companies have joined together to provide funds, engineering expertise, etc., to produce the fluid. One company is designated the unit operator.

Verbal agreement: Spoken rather than written (a -- contract).

Wildcat: A well drilled in an area or formation where no oil or gas production exists. With present-day exploration methods and equipment, about one wildcat out of every nine drilled proves to be productive although not necessarily profitable.

Working interest: The portion of oil production out of which operating and development costs are paid

(i.e., the portion remaining after deduction of royalty interest). Proceeds are paid in the same proportions as the costs.

GEOLOGICAL

GEOLOGICAL

You are now employed in the office of a geologist. A geologist is a scientist whose duties consist of procurement and interpretation of data pertaining to the strata of the earth's crust.

The value of the geologist lies in his ability to evaluate from ordinarily inadequate geological data whether or not the prerequisites for oil accumulation are present in a given area. His recommendations are a measure of these critical factors.

The geologist has to develop a variety of new techniques in order to evaluate all of the evidence bearing upon the merits of oil prospects. He examines, under a microscope, the drill cuttings from previous wellbores in the region to determine the sequence of rock units, especially those which are of sufficient porosity to be interesting as potential reservoirs; and he notes all indications of petroleum content that may show up, such as staining of the rock fragments, odor and certain optical peculiarities of petroleum that cause fluorescence under an ultraviolet light. All of this data is plotted up as ten-foot units on a long strip of paper called a sample log or strip log. (EXHIBIT A)

After analyzing the geological data from all the wells in his area of interest, he selects certain key rock

formations as useful for the preparation of structural maps. By plotting the depths at which these key strata were encountered in various wells in the area.

In the course of these subsurface studies, the geologist may also note changes in the thickness and lithology (rock type) of some of the formations. Where such variations in thickness and porosity affect reservoir beds, they may establish a stratigraphic trap for accumulation. (EXHIBIT B)

Today the industry uses electric and radioactive methods for oil prospecting, the seismic is by far the most useful. (EXHIBIT C) There are two general types of seismic techniques: refraction mapping which is only locally of much importance, and relfection mapping which is the most common method in use for localizing and detailing geological prospects. The reflection seismograph operation is based on the observation that sound waves may be created artificially by the use of explosives. These will be reflected from strata of varying density back to the surface where the sound waves can be recorded and timed in their exact appearance by the recording instrument.

The reflection seismograph technique in coordination with geological reasoning has been by far the most successful tool in finding oil. The gravitometer and magnetometer methods have been more useful in locating salt domes and in reconnaissance searching for rather large structural features--which, generally speaking, are not apt to be found in the better-explored oil provinces today.

Although you will have instruments unique to the geological field, communication to handle, one of your most important duties will be to become familiar with vocabulary and definitions of terms specific to geology and above all you will need to always have all communication, instruments, etc. concerning each client filed so that you may readily locate it for the geologist.

Exhibit D and E are included in this unit because you will probably have occasion to have them filed also.

STRIP LOG - To Plot Lithology

OR SAMPLE LOG (EXHIBIT A)

| | | |
|---|---|---|
| STATE | COMPANY | |
| COUNTY | FARM | WELL NO. |
| BLOCK | SURVEY | |
| SEC. | | |
| T. | R. | TOTAL DEPTH |
| | | CONTRACTOR |
| | | COMMENCED |
| | | COMPLETED |
| ALTITUDE | | REMARKS |
| PRODUCTION | | |

CASING RECORD

| | | |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| SHOT | QUARTS | BETWEEN |

TIME RATE SCALE: 1/10" = MINUTES

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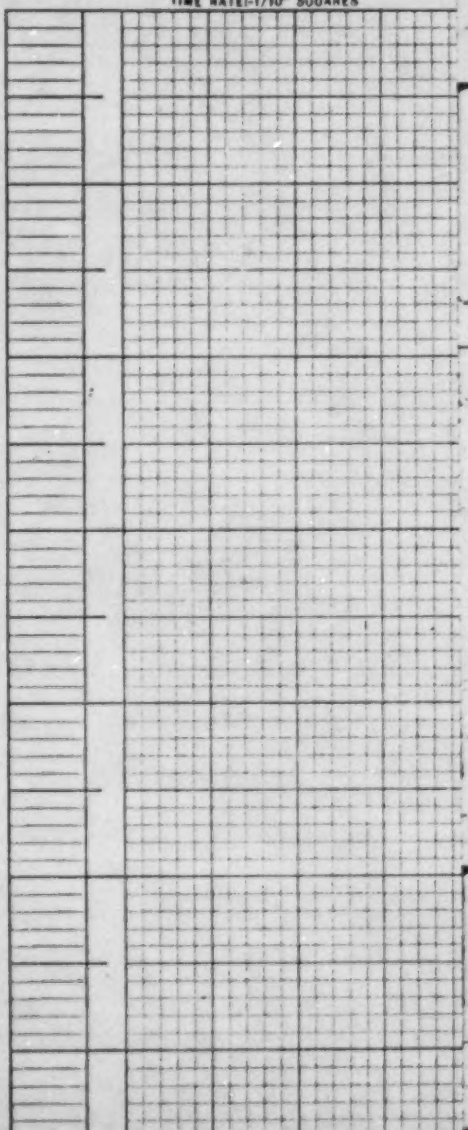
TIME RATE:-1/10" SQUARES



SAMPLE DESCRIPTION - Type of Rock, Perosity, Oil Stain, Fluorescence, etc. (EXHIBIT B)

| STATE | COUNTY | ELEVATION | DESC. BY | COMPANY |
|---|---|---|---|---|
| | | | | |

| KIND OF SAMPLES | LOCATION | S | T | R | FARM | WELL NO. |
|---|---|---|---|---|---|---|
| | | | | | | |

| DEPTH | DOLO % | LIME % | DESCRIPTION | SALT % | ANHY % | SHALE RED | SHALE GRY. | SHALE GRN. | SHALE BLK | SAND RED | SAND GRY. | SAND DESCRIPTION | CHT. % | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |



6908 Advocate Print

Work Sheet for Electrical or Radio-Active Log Interpretation (EXHIBIT C)

# Log Analysis

Schlumberger
PERSIAN DIV

| | | |
|---|---|---|
| CO | COUNTY | STATE |

| DEPTH From | DEPTH To | $t$ Sonic | $\phi_D$ Density | $\phi_N$ Neutron | $R_D$ Deep | | | $R_T$ True | $\phi_S$ Sonic | $\phi_{N-D}$ X-Plot | % $S_W$ | % $S_{XO}$ | $S_W \cdot \phi$ | REMA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

# Log Analysis

Schlumberger
PERMIAN BASIN

| | | | |
|---|---|---|---|
| | | COUNTY | WELL |
| | | | STATE |

| DEPTH From | To | $\Delta t$ Sonic | $\phi_D$ Density | $\phi_N$ Neutron | $R_D$ Deep | | | $R_T$ True | $\phi_S$ Sonic | $\phi_{N-D}$ X-Plot | % $S_W$ | % $S_{XO}$ | $S_W \cdot \phi$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

SCOUT TICKET - Complete info. on a well that has been drilled.

County Well Name, Location Shows, Tests, etc. Field

(EXHIBIT D)

Company Well No.

Lease Elev.

Location Sec. Twp. Rge.

Contractor Tools

Spud /Comp. T.D.

I.P.

Stimulation

Csg. Pres. Tops:

Tbg. Pres.

G O R

Gr.

Csg:

| | |
|---|---|
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(EXHIBIT E)

829 ROSS MARTIN CO. TULSA 1, OKLAHOMA
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# DRILLING TIME REPORT

## PENETRATION RATE - Normally in Minutes per Foot

DATE _____ A.M. OR P.M.

COMPANY _____ COUNTY _____

LEASE _____ TWP _____ SEC _____ RANGE _____

NO. _____ TYPE OF RIG _____

TYPE OF INDICATOR _____ MUD WEIGHT _____

WEIGHT ON DRILL PIPE _____ MUD VISCOSITY _____

R.P.M. ROTARY TABLE _____ CONTRACTOR _____

| DEPTH | | ACTUAL DRILLING TIME | | MINUTES PER | REMARKS | BIT NO. |
|---|---|---|---|---|---|---|
| FROM | TO | BEGAN | ENDED | | | |
| | | | | | | |
| | | | | | | |
| | | |

## GEOLOGICAL

## Vocabulary

AAPG abbr: the abbreviation for the American Association of Petroleum Geologists; leading organization of geologists concerned with the petroleum industry. The national headquarters are in Tulsa, Oklahoma, and the official publication is the AAPG Journal.

Air drilling n: a method of rotary drilling that uses air as the circulation medium. The conventional method of removing cuttings from the wellbore is the use of a flow of water or drilling mud. Since about 1955, it has been known that compressed air (sometimes natural gas) removes the cuttings with equal or greater efficiency. In many cases the rate of penetration is increased appreciably. The principal problems in air drilling are related to the penetration of formations containing water. Entry of water reduces the efficiency of the system and creates other problems.

Anchor n: any device by means of which equipment may be secured or fastened. In downhole equipment, the term often refers to the tail pipe, a pipe extending below a packer and resting on the bottom to resist the weight being applied to set the packer. In offshore drilling, floating drilling vessels are sometimes maintained over the spot where drilling is going on by large metal anchors like those used to anchor ships.

Angle-azimuth indicator n: (See riser-angle indicator.)

Angle of deflection n: in directional drilling, the angle, expressed in degrees, at which a well is deflected from the vertical by means of a whipstock or other deflecting tool.

Angle of deviation n; (See deviation.)

Angle of drift n: (See deviation.)

Angular unconformity n: an unconformity in which the formations on opposite sides of the unconformity are not parallel.

Anhydrite n: the common name for calcium sulfate, $CaSo_4$, which sometimes is called gyp or gypsum. Anhydrite formations are sometimes encountered while drilling.

Anhydrous adj: descriptive of that which is without water.

Annular blowout preventer n: a large valve, usually installed above the ram preventers, that forms a seal in the annular space between the pipe and wellbore or on the wellbore itself if no pipe is present; often called a Hydril after one of the manufacturers of such units.

Annular space n: the space surrounding a cylindrical object within a cylinder. the space around a pipe suspended in a wellbore is often termed the annulus, and its outer wall may be either the wall of the borehole or the casing.

Anticline n: an arched, inverted-trough configuration of folded and stratified rocks; the reverse of a syncline.

API cement class n: a classification system for oil-well cements defined in API Specification 10A

Aquifer n: a rock that contains water. In a water-drive reservoir, the aquifer is that portion of the reservoir that contains the water.

Arenaceous adj: descriptive of sand or sandy rocks (as arenaceous shale).

Argillaceous adj: descriptive of a nonproductive formation that consists of clay or shale (argillaceous sand).

Automatic driller n: (See automatic drilling-control unit.)

Automatic drilling-control unit n: a mechanism used to regulate the amount of weight on the bit on a drilling rig without a person being in constant attendance. Automatic drillers free the driller from the sometimes tedious task of constantly manipulating the drawworks brake in order to maintain correct weight on the bit.

Automation n: the entire subject related to the automatic self-regulating control of equipment, systems, or processes. (See instrumentation.)

Azimuth n: in directional drilling, the direction of the face of the deviation tool with respect to magnetic north as recorded by a deviation instrument.

Backup tongs n: the tongs that are used to back up the drill pipe as it is being made up or taken out of the drill stem. (See make up and tongs.)

Ball sealers n: the nylon, hard rubber, or rubber-covered nylon balls used to shut off perforations that take excessive fluid.

Barite n: barium sulfate, $BaSO_4$; a mineral used to increase the weight of drilling mud. The specific gravity of barite is 4.2 (i.e., about 4.2 times as heavy as water). (See mud.)

Barium sulfate n: a chemical combination of barium, sulfur, and oxygen; barite; a tenacious scale that is very difficult to remove. Chemical symbol is $BaSO_4$.

Basalt n: an igneous rock that is dense, fine grained, and often dark gray to black in color.

Basement rock n: either igneous or metamorphic rock. It usually does not contain petroleum. Ordinarily, it lies below sedimentary rock. When it is encountered in drilling, the well usually is abandoned. (See drill to granite.)

Bed n: a specific layer of earth or rock in contrast to other layers of earth or rock of different material lying above, below, or adjacent to the bed in reference.

Bedding plan n: the surface that separates each successive layer of a stratified rock from its preceding layer.

Bentonite n: a colloidal clay, composed of the mineral montmorillonite, that has the property of swelling when wet. Owing to its gel-forming properties, bentonite is a major component of drilling muds. (See gel and mud.)

BHT abbr: the abbreviation for bottom-hole temperature.

Bioherm n: a reef or mound built by small organisms (as coral, oysters, etc.) Buried bioherms, which were formed in the geologic past, sometimes yield petroleum.

Bit n: the cutting or boring element used in drilling oil and gas wells. It consists of a cutting element and a circulating element. The circulating element permits the passage of drilling fluid and utilizes the hydraulic force of the fluid stream to improve drilling rates. There are three principal kinds of bits

used in rotary drilling: roller-cone bits (rock bits), diamond bits, and fishtail bits (drag bits). Although obsolete, some fishtail bits are still used. The earliest type of drilling bit was the percussion bit for cable-tool drilling. The percussion bit is alternately lifted and dropped while suspended at the end of the drilling cable.

Bitumens n: the mixtures of hydrocarbons.

Bituminous sale n: (See oil shale.)

Black Magic n: a proprietary mixture that is a basic oil-base-mud concentrate. (See oil-base mud.)

Block n: in mechanics, one or more pulleys, or sheaves, mounted to rotate on a common axis; any assembly of pulleys on a common framework; as area of leases appropriate in size for the drilling of exploratory wells (also called a drilling block.) The crown block is an assembly of sheaves mounted on beams at the top of the derrick. The drilling cable is reeved over the sheaves of the crown block alternately with the sheaves of the traveling block, which is hoisted and lowered in the derrick by means of the drilling cable. When elevators are attached to a hook on the traveling block and when drill pipe or tubing is latched in the elevators, the pipe can be raised or lowered in the derrick or mast.

Blooey line n: the discharge pipe from a well being drilled by air drilling. The blooey line is used to conduct the air or gas used for circulation away from the rig to reduce the fire hazard as well as to transport the cuttings a suitable distance from the well.

Blowout n: an uncontrolled flow of gas, oil, or other well fluids from a well to the atmosphere. A well blows out when formation pressure exceeds the pressure being applied to it by the column of drilling fluid and measures are not taken to rectify this situation. A gusher is a blowout.

Blowout preventer (BOP) n: the equipment installed at the wellhead on the surface for the purpose of preventing the escape of pressures in the annular space between the casing and drill pipe or in an open hole during drilling and completion operations. (See annular blowout preventer and ram blowout preventer.)

Bomb n: a thick-walled container, usually made of steel, that is used to receive samples of oil or gas under pressure. (See bottom-hole pressure.)

Bond n: the state of one material being adhered and joined to another material (an cement to formation).

BOP abbr: abbreviation for blowout preventer.

Brackish water n: water that contains relatively low concentrations of any soluble salts. Brackish water is saltier than fresh water but not as salty as salt water.

Break circulation v: to start the mud pump in order to restore circulation of the mud column after the mud pumps have been stopped. As the stagnant drilling fluid has solidified (gelled) during the period of no circulation, a high pump pressure is usually required to break circulation.

Bridge n: an obstruction in the borehole. It is usually formed by the caving of the wall of the borehole or by the intrusior of a large boulder. Also a bridge may be a tool placed in the hole to retain cement or other material that may later be removed or drilled out or remain permanently in place.

Bscf/d abbr: the abbreviation for billion standard cubic feet of gas per day.

Bubble point n: the temperature and pressure at which part of a liquid begins to convert to gas. For example, if a certain volume of liquid is held at constant pressure but the temperature is increased, a point is reached at which bubbles of gas begin to form in the liquid. That point is the bubble point of the liquid. Similarly, if a certain volume of liquid is held at a constant temperature but the pressure is reduced, the point at which gas begins to form is the bubble point. Compare with dew point.

Buildup test n: a test in which a well is shut in for a prescribed period of time and a bottom-hole-pressure bomb run in the well to record increases or decreases in pressure. From this data and the knowledge of pressures in a nearby well, the effective drainage radius can be determined, or the presence of permeability barriers or other production deterrents surrounding the wellbore may be ascertained.

Bullet perforator n: a tubular device that, when lowered to a selected depth within a well, fires bullets through the casing in order to provide holes through which the well fluids may enter. (See perforate.)

Buoyancy n: the apparent loss of weight of an object immersed in a fluid. If the object is floating, the immersed in a fluid. If the object is floating, the immersed portion displaces a volume of fluid the weight of which is equal to the weight of the object.

Cable-tool drilling n: the percussion method of drilling, whereby a heavy bit makes hole by a pounding action. It has largely been replaced by rotary drilling.

Cake thickness n: the measure of the thickness of the filter cake deposited against a permeable medium by a fluid containing suspended solids.

Calcium carbonate n: a chemical conbination of calcium, carbon, and oxygen; main constituent of limestone. Calcium carbonate forms a tenacious white scale in water-handling facilities and is one of the compounds that causes water hardness. Chemical symbol is $CaCO_3$.

Calcium chloride n: a moisture-absorbing chemical (a desiccant) used as an accelerator in cements and as a drying agent. Chemical symbol is $CaCl_2$.

Caliper log n: a record whereby the diameter of the wellbore or the internal diameter of tubular goods is ascertained. The log indicates undue enlargement of the wellbore due to caving, washout, or other causes. In tubular goods, the caliper log reveals internal corrosion, scaline, or pitting.

Cap rock n: the impermeable rock overlying an oil or gas reservoir that tends to prevent migration of the reservoir; the porous and permeable strata overlying salt domes that may serve as the reservoir rock.

Carbonate reef n: (See reef.)

Carbonate rock n: a sedimentary rock that is primarily composed of calcium carbonate (limestone) or calcium magnesium carbonate (dolomite). Sometimes petroleum reservoirs are made up of carbonate rocks.

Carboxymethyl cellulose (CMC) n: a nonfermenting cellulose product used in drilling fluids to combat contamination from anhydrite (gyp) and to lower the water loss of the mud; abbreviated CMC.

Casing string n: the total footage of casing run in a well. In deep wells, high tensile strength is required in the top casing joints to carry the load, whereas high collapse resistance and high internal yield strength is needed in the bottom joints. In the middle of the string,

average tensile strength and average collapse and bursting resistance are suggicient. By using the appropriate combination of kinds and weights of pipe in a long string, a combination string can be designed to best withstand the conditions encountered during the life of the well and allow for efficient production at a minimum of cost.

Casing swage n: a solid, cylindrical body, pointed at the bottom and equipped with a tool joint at the top for connection with a jar, which is used to provide an opening in collapsed casing and drive it back to its original shape.

Casing tongs n: (See tongs.)

Catch samples v: to obtain cuttings made by the bit as formations are penetrated so that they may be studied by geologists. Members of the drilling crews obtain these samples from the drilling fluid as is emerges from the wellbore or from the bailer in cable-tool drilling. Cuttings so obtained are carefully washed until they are free of foreign matter and then dried and labeled to show the depth from which they originated.

Caustic soda n: a common term for sodium hydroxide. It is used to maintain an alkaline pH in drilling mud and in the treating of petroleum fractions. Chemical symbol is NaOH.

Cavernous formation n: a rock formation that contains large, open spaces, usually the result of dissolving by formation waters that may or may not still be present. (See vug.)

Cement bond n: the adherence of casing to cement and cement to formation; when casing is run in a well, it is set, or bonded, to the formation wall by means of cement. The cement bond may be good, bad, or anywhere in between, although a good cement bond is usually necessary.

Cement-bond survey n: an acoustic survey or sonic-logging method that records the quality or hardness of cement in the annulus between the casing and formation. Casing that is well bonded to the formation by cement shows a fast transit time of an acoustic signal. Casing that is not well bonded shows a slower transit time of an acoustic signal.

Cementing time n: the total elapsed time for a cementing operation from the beginning of mixing until the completion of displacement to final depth and complete circulation of any excess slurry to the surface.

Centigrade (Celslus) scale n: the metric system of temperature measurement that is used almost universally for scientific purposes. In the centrigrade scale, 0 represents the freezing point of water and 100 its boiling point at 7600-mm barometric pressure. Degrees centigrade may be converted to degrees Fahrenheit by the following equation:

$$^{o}F = 9/5(^{o}C) + 32.$$

Christmas tree n: the control valves, pressure gauges, and chokes assembled at the top of a well to control the flow of oil and gas, usually from the tubing head.

Circulating head n: an accessory attached to the top of the drill pipe or tubing to form a connection with the mud system to permit circulation of the drilling mud. In some cases it is also a rotating head, which permits the pipe to be turned during circulation.

Clastic rocks n: the sedimentary rocks that are composed of fragments of preexisting rocks. Sandstone is a clastic rock.

Clay n: a fine, crystalline material of hydrous silicates, resulting primarily from the decomposition of feldspathic rocks.

Closing ratio n: the ratio between the pressure in the hole and the operating-piston pressure needed to close the rams of a blowout preventer.

Closure n: the vertical distance between the top of an anticline, or dome, and the lowest point marking the end of such a structure. Closure is important in that it is an indication of the amount of producing formation that can be expected to be encountered.

Coagulation n: (See flocculation.)

Combination trap n: a subsurface hydrocarbon trap that is partly structural and partly stratigraphic. (See structural trap and stratigraphic trap.)

Common cement n: a regular portland cement that may be classified as either API Class A cement or ASTM Type 1 cement.

Composite sample n: a quantity of a substance that is composed of several substances mixed together for testing purposes. In sampling a crude-oil storage tanks a composite sample is made up from samples taken at the top, midpoint, and bottom of the tank.

Condensation n: the process by which vapors are converted into liquids. Condensation is accomplished chiefly by cooling the vapors. Retrograde condensation is the phenomenon that deals with the phase (liquid and vapor) behavior of a hydrocarbon mixture in the critical region where gas is converted to a liquid through a reduction in pressure.

Condition v: to treat drilling mud with additives to give it the desired properties; sometimes applied to treatment of water for use in boilers, in drilling operations, etc. To condition and circulate mud refers to the fact that it is necessary to circulate the mud through the mud system while conditioning with additives to distribute the additives uniformly throughout all the mud in the system.

Conductivity n: the ability to transmit or convey (as heat or electricity); the electrical-logging measurement that is obtained from an induction survey, whereby an alternating magnetic field produces eddy currents in the formation. These eddy currents induce a voltage in a receiver coil. This voltage is proportionate to the ability of the formations to conduct electricity and is recorded as the condutivity.

Conglomerate n: a sedimentary rock composed of pebbles of various sizes held together by cementing materials. Conglomerates are similar to sandstone but have larger grains.

Coning n: the process of reservoir water invading the oil column and entering the well because of uncontrolled production.

Connate water n: the water originally in place in the pores, or interstices, of a formation (i.e., water retained in the pore spaces from the time the formation was laid down). Often connate water is termed interstitial water, although this term means any water contained in the pore spaces, whether connate or not.

Continental shelf n: a zone adjacent to a continent that extends from the low-water line to the point at which there is a steep slope to a depth of 600 ft or more.

Core v: to produce a sample, or core, of a formation for purposes of obtaining geological information.

Core analysis n: a study of a core in a laboratory to determine the following properties of the formation from which the core was taken: porosity, permeability, fluid content, angle of dip, geological age, lithology, and probable productivity.

Core barrel n: a device used in rotary drilling to cut cores. The core barrel, varying in length from 25 to 60 ft, is run at the bottom of the drill pipe in place of a bit or in conjenction with a special bit.

Core catcher n: the part of the core barrel that retains the core cut by the core cutterhead.

Core cutterhead n: the element of the core-barrel assembly that cuts the core from the formation. In design it corresponds to one of the three main types of bits: drag bits with blades for cutting soft formations; roller bits with rotating cutters for cutting medium-hard formations; and diamond bits for cutting very hard formations.

crd abbr: the abbreviation for cored; used in drilling reports.

crg abbr: the abbreviation for coring; used in drilling reports.

Critical temperature n: the highest temperature at which it is possible to separate substances into two fluid phases (vapor and liquid).

Crooked hole n: a wellbore that has deviated from the vertical. A crooked-hole area is one where the subsurface formations are so composed or arranged that it is difficult to drill a straight hole. On example of such an area is a section of alternating hard and soft strata steeply inclined from the horizontal.

Crown block n: an assembly of sheaves mounted on beams at the top of the derrick. (See block.)

Crow's nest n: any elevated walkway where men work (e.g., on the top of a derrick or refinery tower).

Curing n: the aging of cement under specified conditions of temperature and pressure.

Cushion n: a column of water or drilling fluid that purposely is placed inside drill pipe or tubing to prevent the pipe or tubing from being crushed by the hydrostatic pressure of the fluid in the annulus of the wellbore. Usually the pipe or tubing is full of fluid, but in certain operations it is necessary to run the pipe or tubing nearly empty in order to have less pressure inside the pipe than in the annulus. In such cases, a cushion may be necessary to prevent collapse of the pipe.

Daily drilling report n: a record that is made each day of all the important occurrences on a working drilling rig. (See driller's report.)

D&A abbr: the abbreviation for dry and abandoned; used in drilling reports.

Darcy n: a unit of measure of permeability, the ease with which a rock can transmit fluids. A porous medium has a permeability of 1 darcy when a pressure of 1 atmosphere on a sample 1 cm long and 1 $cm^2$ of cross section will force a liquid of 1-cp viscosity through the sample at the rate of 1 $cm^3$ per second. The permeability of reservoir rocks is usually of such small magnitude that it must be measured in millidarcies (1/1,000 darcy).

DC abbr: the abbreviation for drill collar; used in drilling reports.

Deepen v: to drill a well deeper. Deepening is generally a workover operation carried out with the view of producing from a deeper formation or to control excessive gas found in the upper levels of a reservoir.

Deepwater drilling n: the offshore drilling operations that occur in relatively deep oceans or seas. Deepwater drilling presents a number of special problems connected with water depth that must be overcome if the venture is to be successful.

Deflection n: a change in the angle of a wellbore. In directional drilling, deflection is measured in degrees from the vertical.

Deposit n: an accummulation of petroleum capable of being produced; anything laid down.

Depositional environment n: the conditions under which a series of rocks were laid down. Depositional environments are broadly divided into five groups: aeolian (meaning wind-borne deposits), alluvial (meaning river-borne deposits), deltaic (meaning deposits borne by a river where it enters the sea), interdeltaic (meaning deposits laid down between river deltas), and marine (meaning ocean-borne deposits).

Depth in, depth out n: the measurements made in connection with running bits or other equipment in the hole and pulling the equipment out again. For example, a new bit may be put in the hole at a certain depth, a number of feet of new hole drilled with it, and the bit pulled out of the hole. The depth of the hole when the new bit was run in the hole is depth in; the depth of the hole when the bit was pulled out of the hole is depth out.

Depthometer n: a device used to measure the depth of a well or to a specific point in a well (as to the top of a liner or to a fish) by counting the turns of a calibrated wheel roling on a wire line as it is lowered into or pulled out of a well.

Derrick n: any one of a large number of load-bearing structures. In drilling work, the standard derrick has four legs standing at the corners of the substructure and reaching to the crown block. The substructure is an assembly of heavy beams used to elevate the derrick above the ground and provide space to install blowout preventers casing heads, etc. The standard derrick has largely been replaced by the mast for drilling because the mast can be lowered and raised without disassembly whereas the standard derrick is of bolted construction and must be assembled part by part.

Derrickman n: the crew member whose work station is uppermost in the derrick while the drill stem is being hoisted or lowered into the hole. His responsibilities also include the conditioning of the drilling fluid and the circulating machinery.

Desalt v: to remove dissolved salt from crude oil. Desalting may include the injection of fresh water into the crude stream in order to dissolve the salt for removal by electrostatic treaters.

Desander n: a centrifugal device for removing sand from drilling fluid to prevent abrasion of the pumps. A desander may be operated mechanically or by a fast-moving stream of fluid inside a special cone-shaped vessel, in which case it is sometimes called a hydrocyclone desilter. (See desilter.)

Desk and Derrick Club n: an organization of secretaries, clerks, etc., (usually women) employed in the oil industry. Such clubs now exist in about a dozen major oil centers. The purpose of the organization is partly educational and partly social.

Development well n: a well drilled in proven territory in a field for the purpose of completing the desired pattern of production; sometimes called an exploitation well.

Deviation n: the inclination of the wellbore from vertical. The angle of deviation, angle of drift, or drift angle is the angle in degrees, taken at one or at several points, that shows the variation from the vertical as revealed by a deviation survey.

Deviation survey n: a survey to obtain the angle through which the bit has deviated from the vertical during drilling operations. The deviation may have been intentional or inadvertent. There are two basic kinds of deviation-surveying instruments; one reveals the angle of deviation only, and the other reveals both the angle and the direction of deviation. Also called a drift survey.

Dew point n: the temperature and pressure at which a liquid begins to form out of a gas, or condense. For example, if a constant pressure is held on a certain volume of gas but the temperature reduced, a point is reached at which droplets of liquid condense out of the gas. That point at which liquid begins to form is the dew point of the gas at that pressure. Similarly, if a constant temperature is held on a certain volume of gas but the pressure increased, again a point is reached at which liquid begins to condense out of the gas. That point at which liquid begins to form is the dew point of the gas at that temperature. Compare with bubble point.

DF abbr: the abbreviation for derrick floor; used in drilling reports.

Diagenesis n: the chemical and physical changes that sediments undergo after their deposition, compaction, cementation, recrystallization, and perhaps replacement, which result in lithification.

Diameter n: the distance across a circle measured through the center. In the measurement of pipe diameters, the inside diameter--ID--is that of the interior circle, whereas the outside diameter--OD--is the diameter of the circle formed by the exterior surface of the pipe.

Diamond bit n: a drilling bit that has a steel body surfaced with many industrial diamonds. The cutting operation is performed by the rotational action of the very hard diamonds over the rock surface.

Diatomaceous earth n: a deposit made up of the siliceous cell walls of one-celled marine algae known as diatoms. It is used as an admixture for cement to produce a low-density slurry.

Dip n: (See formation dip.)

Dip log n: a survey of a wellbore with a dip meter to determine the direction and angle of dip of certain formations exposed in it.

Dipmeter survey n: an oil-well-surveying method that determines the direction and angle of formation dip in relation

to the borehole. A dipmeter survey records data so that both the amount and direction of formation dip relative to the axis of the hole can be computed. This survey is useful when it is desirable to obtain information about the geologic structure of the formation.

Directional drilling n: the intentional deviation of a wellbore from vertical. Although wellbores are normally planned to be drilled vertically, many occasions arise when it is necessary or advantageous to drill at an angle from the vertical. Controlled directional drilling makes it possible to reach subsurface points laterally remote from the point where the bit enters the earth. Directional drilling involves the use of turbodrills, Dyna-Drills, whipstocks, or other deflecting tools to deviate the hole in the desired direction.

Directional hole n: a wellbore purposely drilled at some angle from vertical. (See directional drilling.)

Directional survey n: a logging method that records hole drift--deviation from vertical--and the direction of that drift. A single-shot directional-survey instrument makes a single photograph of a compass reading of the drift direction and the number of degrees the hole is off vertical. A multishot survey instrument is used to obtain numerous readings in the hole as the device is pulled out of the well. (See directional drilling.)

Dispersion n: a suspension of extremely fine particles in a liquid (as colloids in a colloidal solution).

Displacement n: the weight of fluid (as water) displaced by a freely floating body (as an offshore drilling rig), such weight being exactly equal to the weight of the rig and everything on board.

Dissociation n: the splitting up of a compound with two or more simple molecules, atoms, or ions. Hydrochloric acid dissociates into hydrogen and chlorine molecules, or ions, in water.

Distillate n: a product of distillation, or the liquid condensed from the vapor produced in a still; heavy gasoline or light kerosines that are used as fuels.

Dome n: a geologic structure resembling an inverted bowl; a short anticline, plunging on all sides. (See salt dome.)

Doodlebug n: the seismograph that is used in prospecting for potential oil-bearing geological structures (slang); the various devices used in searching for petroleum deposits (slang).

DP abbr: the abbreviation for drill pipe; used in drilling reports.

Drift v: to move slowly out of alignment, off center, or out of register; to gauge, or measure, pipe by means of a mandrel passed through it in order to ensure the passage of tools, pumps, etc.

Drill bit n: (See bit.)

Drill collar n: a heavy, thick-walled tube, usually steel, employed between the drill pipe and the bit in the drill stem to provide weight on the bit in order to improve its performance.

Driller n: the employee directly in charge of a drilling or workover rig and crew. The operation of the drilling and hoisting equipment constitutes his main duty, but he is also responsible for the downhole condition of the well, pipe measurements, and operation of downhole tools.

Driller's BOP control panel n: a series of controls on the rig floor that the driller manipulates to open and close the blowout preventers.

Driller's log n: a record maintained at the drilling rig giving a visual description of the formation encountered and the drilling time relative to depth, usually in 5- to 10-ft intervals.

Driller's report n: a record keep on the rig for each tour to show the footage drilled, drilling-fluid tests, bit record, and all important occurrences during that tour.

Drilling break n: a sudden increase in the rate of penetration by the drill bit, which may indicate that the bit has penetrated a high-pressure zone and thus the possibility of a blowout, although this is not always true.

Drill out v: to remove with the bit the residual cement that normally remains in the lower section of casing and the wellbore after the casing has been cemented.

Drill pipe n: in rotary drilling, the heavy, seamless tubing used to rotate the bit and circulate the drilling fluid. Joints of pipe 30 ft in length are commonly used and are coupled together with tool joints.

Drill stem n: the entire length of tubular pipes, composed of drill pipe and drill collars, that make up the drilling assembly from surface to bottom.

Drill-stem test n: (See formation testing.)

Drill string n: the column, or string, of drill pipe not including the drill collars.

Drill to granite v: a wildcatter's term that is loosely applied to mean to drill the hole until basement rock is encountered. If no hydrocarbon-bearing formations are found above the basement, the well is assumed to be dry.

Drill under pressure v: to carry on drilling operations while maintaining a seal (usually with a rotating head) to prevent the well fluids from blowing out. Drilling under pressure is advantageous in that the rate of penetration may be relatively fast; however, the technique must be applied with caution and only with well-trained drilling personnel.

Dry drilling n: a drilling operation in which no fluid is being circulated back to the surface; often results from lost circulation. The term is a misnomer in that fluid is usually circulated into the well to cool the bit even though the fluid does not return to the surface. (See blind drilling.)

Dry hole n: any well that does not produce oil or gas in commercial quantities. This term is somewhat loosely used in oil work. A dry hole may flow water or gas or may even yield some oil but not in commercial quantities.

DST abbr: the abbreviation for drill-stem test. (See formation testing.)

Dual completion n: a single well from which two separate formations may be produced at the same time. Production from each zone is segregated by running two tubing strings with packers inside the single string of production casing, or one tubing string with a packer may be run, and the other zone produced through the annulus. A miniaturized dual completion may be employed in which two separate 4½-in. or smaller casing strings are run and cemented in the same wellbore, or a dual tubingless completion could be utilized.

Effective permeability n: the permeability of a rock to a fluid when the saturation of the fluid is less than 100 percent.

Effective porosity n: the percentage of the bulk volume of a rock sample that is composed of interconnected pore spaces, allowing the passage of fluids through the sample. (See porosity.)

Electrical well log n: the record of certain electrical characteristics of the formations traversed by the borehole for the purpose of identifying the formations and making determinations regarding the nature and amount of fluids they contain and their locations in terms of depth. Also called an electric log, or an electric survey.

Element n: one of more than 100 simple substances that consist of atoms of only one kind and that either singly or in combination make up all matter. The simplest element is hydrogen. One of the more abundant elements is carbon. Radioactive elements include radium, uranium, and a number of newly discovered, short-lived elements (as californium, berkelium, etc.).

Exploitation n: the development of a reservoir to extract the oil.

Exploration n: the search for oil and gas, which includes, among other things, aerial and geophysical surveys, geological studies, core testing, and the drilling of wildcat wells.

Exploration well n: a wildcat well.

Extrusive rocks n: the igneous rocks that are formed from lava poured out on the surface of the earth.

Fahrenheit scale n: a temperature scale invented by Gabriel Fahrenheit in which 32° represents the freezing point of water and 212° its boiling point at standard sea-level pressure. Fahrenheit degrees may be converted to centigrade degrees by the following formula:

$$^{\circ}C = 5/9(^{\circ}F - 32)$$

Fault n: a geological term denoting a break in the subsurface strata. Often strata on one side of the fault line have been displaced upward, downward, or laterally relative to their original position.

Fault plane n: a surface along which faulting has taken place.

Fault trap n: a subsurface hydrocarbon trap in which an impermeable rock layer has been moved opposite the reservoir bed along a fault.

Filter cake n: a compacted solid or semisolid material remaining on a filter after pressure filtration of mud with the standard filter press. Thickness of the cake is reported in thirty-seconds of an inch. Filter cake may also refer to the layer of concentrated solids from the drilling mud that forms on the walls of the borehole opposite permeable formations, which is usually called wall cake or mud cake.

Filter loss n: the amount of fluid delivered through a permeable filter medium after being subjected to a differential pressure for a specified time.

Filtration n: the process of filtering a fluid; the escape of the liquid phase of drilling fluid into permeable formations.

Filtration loss n: the escape of the liquid part of a drilling mud into permeable formations.

Fine n: a very small fragment or particle of rock or mineral that is too small to be treated in the same way as ordinary coarse material.

Fissure n: a crack or fracture that occurs in a subsurface formation.

Float collar n: a special coupling device that is inserted one or two joints above the bottom of the casing string and that contains a check valve that permits fluid to pass downward through the casing but prevents it from passing upward. The float collar prevents the drilling mud from entering the casing while it is being lowered, thus allowing the casing to float during its descent and decreasing the load on the derrick. The float collar also prevents the backflow of cement during the cementing operation.

Flocculation n: the action of contaminants or special additives in a drilling fluid that causes the solids to come together in a mass (i.e., to coagulate).

Fluid sampler n: an automatic device for periodically taking a sample of a fluid flowing in a pipe.

Foam drilling n: (See mist drilling.)

Fold n: a flexure of rock strata into arches and troughs produced by earth movements. (See anticline and syncline.)

Formation boundary n: the limits of the horizontal extent of a formation.

Formation damage n: the reduction of permeability in a reservoir rock arising from the invasion of drilling fluid and treating fluids into the section adjacent to the wellbore. Often called skin.

Formation dip n: the angle at which a formation bed inclines away from the horizontal; indicated on geological maps by an arrow with a figure alongside giving the inclination in degrees.

Formation fracturing n: a method of stimulating production by increaseing the permeability of the producing formation. Under extremely high hydraulic pressure, a fluid (as distillate, diesel fuel, crude oil, dilute hydrochloric acid, water, liquefied petroleum gas, or kerosine) is pumped downward through production tubing or drill pipe and forced out below a packer or between two packers. The pressure causes cracks to open in the formation, and the fluid penetrates the formation through the cracks. Sand grains, aluminum pellets, walnut shells, or similar materials are carried in suspension by the fluid into the cracks. These are called propping agents, or proppants. When the pressure is released at the surface, the fracturing fluid returns to the well. The cracks partially close on the proppants, leaving channels for oil to flow around them to the well. This term is often shortened to frac job.

Formation pressure n: the force exerted by fluids in a formation, recorded in the hole at the level of the formation with the well shut in. Formation pressure may also be termed reservoir pressure, or shut-in bottom-hole pressure.

Formation testing n: the gathering of data on a formation to determine its potential productivity before installing casing in a well. The conventional method is the drill-stem test. Incorporated in the drill-stem-testing tool are a packer, valves and/or ports that may be opened and closed from the surface, and a pressure-recording device. The tool is lowered to bottom on a string of drill pipe and the packer set, isolating the formation to be tested from the formations above and supporting the fluid column above the packer. A port on the tool is opened to allow the trapped pressure below the packer to bleed off into the drill pipe, gradually exposing the formation to atmospheric pressure and allowing the well to produce to the surface, where the well fluids may be sampled and inspected. From a record of the pressure readings, a number of facts about the formation may be inferred.

Fossil n: the remains or impressions of a plant or animal of past geological ages that have been preserved in or as rock.

Free water n: the water produced with oil that settles out within five minutes while the well fluids are stationary in a settling space within a vessel. Compare with emulsified water.

Fresh water n: water that has a very low or no concentration of salts dissolved in it.

Gas-cut mud n: a drilling mud with entrained formation gas that gives the mud a characteristic fluffy texture. Because the presence of a large amount of gas in the mud lowers its density, such mud requires treatment to avoid the danger of a blowout. However, since a small volume of gas expands as it reaches the surface, often it need not be of concern.

Gas cut n: the retention by drilling fluid of gas that was entrained during drilling. When a drilling fluid is not able to release entrained gas before returning to the well, that fluid becomes gas cut, and the hydrostatic head of the fluid column is reduced. Thick fluid cuts more readily than thin.

Gas-oil contact n: the point or plane at which the bottom of a gas sand is in contact with the top of an oil sand in a reservoir.

Gas show n: the gas that appears in the drilling-fluid returns, indicating the presence of a gas zone.

Geologic-time scale n: the long period of time dealt with by geology. Geologic time is divided into eras: Cenozoic, Mesozoic, Cambrian, and Precambrian; eras are further subdivided into periods and epochs. Upon investigation, rock strata can be assigned a place in the scale and thus can be referred to as Mesozoic rocks of the Triassic period and so on.

Geologist n: a scientist whose duties consist of procurement and interpretation of data pertaining to the strata of the earth's crust.

Geolograph n: a trade name for a patented device that automatically records the rate of penetration and depth during drilling operations; a Geolograph is a rate-of-penetration recorder. Interestingly, this term is applied to almost any brand of rate-of-penetration recorder, much as Jell-O is used to refer to any brand of flavored-geletin dessert.

Geology n: the science that relates to the study of the structure, origin, history, and developments of the earth and its inhabitants as revealed in the study of rocks, structures, and fossils.

Geophone n: an instrument designed to detect vibrations passing through the earth's crust. It is used in conjunction with seismorgraphy. (See seismograph.) Geophones are often called jugs.

Geosyncline n: a part of the surface of the earth that sank deeply over a long period of time; a great trough hundreds of miles long and tens of miles wide that received thousands of feet of sedimentary and volcanic rock over millions of years.

Geothermal gradient n: the increase in the temperature of the earth with the increasing depth from the surface; averages about 1 F per 60 ft, but may be considerably greater.

Geothermal reservoir n: a subsurface layer of rock that contains steam or hot water, which is trapped in the layer by overlying impermeable rocks; a subsurface layer of rock that is hot but contains little or no water. Geothermal reservoirs are a potential source of energy.

Gilsonite n: a naturally occurring solid hydrocarbon belonging to the asphalt group. A granular form of Gilsonite is sometimes used as a cement additive to prevent lost circulation.

GOR abbr; the abbreviation for gas-oil ratio.

Graben n: a geologic term for a block of the earth's crust that has moved downward between two faults. The opposite of a horst.

Granite n: an igneous rock composed primarily of feldspar, quartz, and mica. It usually does not contain petroleum.

Gumbo n: any relatively sticky formation (as clay) encountered in drilling.

Gusher n: an oil well that comes in with such great pressure that the oil flows out of the well somewhat like a geyser. In reality, a gusher is a blowout and is extremely wasteful of reservoir fluids and drive energy. In the early days of the oil industry, gushers were quite common and, many times, were the only way in which drillers knew that a large quantity of oil or gas had been struck.

Gypsum n: a naturally occurring crystalline form of calcium sulfate combined with two molecules of water. (See calcium sulfate and anhydrite.)

HOCM abbr: the abbreviation for heavy oil-cut mud; used in drilling reports.

Homocline n: a series of beds dipping in one direction.

Honeycomb formation n: a stratum of rock that contains large void spaces; synonomous with cavernous formation or vugular formation.

Hydrate n: the hydrocarbon and water compound that is formed in gathering, compression, and transmission facilities for gas under reduced temperature and pressure. Hydrates often accumulate in troublesome amounts and impede snow or ice.

Hydrochloric acid n: an acid compound commonly used to acidize carbonate rocks; prepared by mixing hydrogen chloride gas in water; also known as muriatic acid. Chemical symbol is HCl.

Hydrogen sulfide n: one of the gaseous compounds of sulfur and hydrogen commonly found in petroleum, which accounts for the foul smell of some petroleum factions that are called sour. Hydrogen sulfide is extremely poisonous and corrosive. Chemical symbol is $H_2S$.

Hydorstatic head n: (See hydraulic head.)

Igneous rock n: a rock mass formed by the solidification of molten material injected into the earth's crust or extended out on its surface. Granite is an igneous rock.

Ilmenite n: an iron-black mineral of composition $FeTiO_3$ or $FeO\ TiO_2$ with a specific gravity of about 4.67. It is sometimes used for increasing the density of oil-well cement slurries.

Immiscible adj: descriptive of substances that are not capable of mixing or being mixed (as oil and water).

Impermeable adj: descriptive of not allowing the passage of fluid. A formation may be porous yet impermeable due to the absence of connecting passages between the voids within it. (See permeability.)

Infilling well n: a well drilled between known producing wells to better exploit the reservoir.

Inhibited mud n: a drilling fluid to which chemicals have been added to prevent the filtrate from causing clay particles in a formation to swell, thus impairing the permeability of a productive zone. Salt is often used for this purpose.

Intrusive rock n: an igneous rock that, while in molten state, has penetrated into or between other rocks and has solidified.

Invaded zone n: an area within a permeable rock around a wellbore into which filtrate (normally water) from the drilling mud has passed, with the consequent partial or total displacement of the fluids originally present in the zone.

Isopach map n: a geological map of subsurface strata showing the varying thicknesses of a given formation underlying an area. It is widely used in the calculation of reserves, in planning secondary-recovery projects, and in general exploitation work.

Jack-up drilling rig n: an offshore drilling structure with tubular or derrick legs that support the deck and hull. When positioned over the drilling site, the bottoms of the legs rest on the seafloor. A jack-up rig is towed or propelled to the location with the legs up, and machinery is engaged to move the legs to the seafloor while the deck and hull (the area provided working and living space) remain above the water. Once the legs are firmly positioned on bottom, the deck height may be further adjusted and leveled.

Jet bit n: a drilling bit having nozzles through which the drilling fluid is directed in a high-velocity stream to the bottom of the hole to improve the efficiency of the bit. (See bit.)

Jet-perforate v: to burn a hole through the casing with a shaped charge of high explosives instead of a gun that fires a projectile, as is used in bullet perforating. The gun with loaded charges is lowered into the hole to the desired depth. Once detonated, the charges form short, penetrating jets of high-pressure gases that produce holes in the casing and cement and some distance in the formation. Formation fluids then flow into the wellbore through these holes, or perforations. (See bullet perforator and gun-perforate.)

Joint n: a single length of drill pipe, drill collar, casing, tubing, or rod that has threaded connections at both ends. A joint of drill pipe is usually 30 ft long. Several joints screwed together constitute a stand of pipe. (See double, thribble, and fourble.)

Junk n: the metal debris lost in a hole. Junk may be a lost bit, pieces of a bit, milled pieces of pipe, wrenches, or any relatively small object that impedes drilling to the extent that it must be fished out of the hole.

Junk basket n: a device made up on the bottom of the drill stem to cut a core into the bottom of the hole on which junk rests. As the core is cut, the junk enters a barrel in the tool and is retained therein by metal projections (catchers). The junk comes out of the hole along with the core when the basket in brought back to the surface.

K abbr: the abbreviation for degree Kelvin. (See Kelvin temperature scale.)

KB abbr: the abbreviation for kelly bushing; used in drilling reports.

Kelly n: the heavy, square or hexagonal, steel member that is suspended from the swivel through the rotary table and is connected to the topmost joint of drill pipe to turn the drill stem as the rotary table turns. It has a bored passageway that permits fluid to be circulated from the swivel into the drill stem and up the annulus, or vice versa.

Kelly bushing n: a device fitted to the rotary table through which the kelly passes and by means of which the torque of the rotary table is transmitted to the kelly and to the drill stem.

Kelly cock n: a valve installed between the swivel and the kelly. When a high-pressure backflow begins inside the drill stem, an operator can close this valve and keep the pressure off the swivel and rotary hose.

Kelly saver sub n: a saver sub that fits in the drill stem between the kelly and drill pipe. Since a large number of joints of drill pipe are made up on the kelly, the saver minimizes wear on the threads of the kelly in that the drill pipe actually mates with the threads of the saver rather than the kelly.

Kelvin temperature scale n: a temperature scale with the degree interval of the centigrade scale and the zero point at absolute zero. On the Kelvin scale, water freezes at 273° and boils at 373°. (See absolute temperature scale.)

Key seat n: a channel or groove cut in the side of the hole parallel to the axis of the hole. Key seating takes place as a result of the dragging action of pipe on a sharp bend in the hole. In machine work, a key seat is a groove cut in a shaft or pulley bore parallel with the axis.

Kick n: an entry of water, gas, oil, or other formation fluid into the wellbore. A kick occurs because the pressure exerted by the column of drilling fluid is not great enough to overcome the pressure exerted by the fluids in the formation drilled. If prompt and proper action is not taken to kill the well, then a blowout will occur.

Kill v: in drilling, to prevent the threatened blowout of a well by suitable preventive measures (e.g., to shut

in the well with the blowout preventers, circulate the kick out, and increase the weight of the drilling mud); in production, to stop a well from producing oil and gas so that reconditioning of the well may proceed. In both cases it is usually accomplished by the injection of a dense fluid into the well.

Kill sheet n: a printed form that contains blank spaces for recording information necessary to kill an impending blowout. Kill sheets are provided to remind personnel of the necessary steps to take to kill a well and to give them a convenient space in which to write down the necessary data.

Kill line n: a high-pressure line that connects the mud pump and the well and through which heavy drilling fluid can be pumped into the well to control a threatened blowout.

Kinematic viscosity n: the absolute viscosity of a fluid divided by the density of the fluid at the temperature of the viscosity measurement.

Knowledge box n: the cupboard or desk in which the driller keeps the various records pertaining to the drilling operation (slang).

Lignosulfonate n: an organic, drilling-fluid additive derived from by-products of a papermaking process using sulfite. It is added to drilling mud to minimize fluid loss and to reduce the viscosity of the mud.

Lime n: a caustic solid that consists primarily of calcium oxide (CaO). Many forms of CaO are called lime, including the various chemical and physical forms of quicklime, hydrated lime, and even calcium carbonate. Also, limestone is sometimes called lime.

Limestone n: a type of sedimentary rock rich in calcium carbonate. Limestone sometimes serves as reservoir rock for petroleum.

Lithification n: the conversion of unconsolidated deposits into solid rock.

Lithology n: the study of rocks, usually the macroscopic study thereof. Also, the term is used to express the individual character of rocks in terms of mineral composition, structure, etc.

Log n: a systematic recording of data (as from a driller's log, mud log, electrical well log, radioactivity log,

etc.). A large number of different logs are run in producing wells and wells being drilled in order to obtain various characteristics of downhole formations.

Log a well v: to run any of the various logs that may be used to ascertain downhole information about a well.

Logbook n: a book used by station engineers and gaugers to keep notes of current operating conditions and other useful information.

Log sheet n: a daily report sheet on which operating data is entered by gaugers, dispatchers, and station engineers.

Lost circulation n: the loss of quantities of whole mud to a formation, usually cavernous, fissured, or coarsely permeable beds, evidenced by the complete or partial failure of the mud to return to the surface as it is being circulated in the hole. Lost circulation is an abnormal condition when drilling a well, and usually every attempt is made to regain circulation. It can lead to a blowout and, in general, reduces the efficiency of the drilling operation. Lost circulation also is called lost returns.

Lost-circulation material n: a substance added to cement slurries or drilling muds that is designed to prevent the loss of cement or mud to the formation. (See bridging material.)

Lost hole n: a well that, for one reason or another, cannot be further drilled or produced. Some of the reasons a hole may be lost are a blowout or an unsuccessful fishing job.

Lubricator n: a specially fabricated length of casing or tubing that is usually temporarily placed above a valve on top of the casing or tubing head. Lubricators are using to run tools or substances into a producing well without having to kill the well (make it stop producing). For this reason, lubricators afford a method of sealing off pressure yet still allow the passage of a device, usually on a wire line, or substance into the well.

Marginal well n: a well that is approaching depletion of its desired natural resource to the extent that any profit from its continued production is doubtful.

Marl n: a semisolid or unconsolidated clay, silt, or sand.

Mcf abbr: the abbreviation for 1,000 $ft^3$ of gas. This term is commonly used to express the volume of gas produced, transmitted, or consumed in a given period of time.

Mcf/d abbr: the abbreviation for 1,000 $ft^3$ of gas per day.

Methane series n: the paraffin series of hydrocarbons. (See hydorcarbons.)

Mica n: a silicate mineral that is characterized by a sheet cleavage. Biotite is the ferromagnesian black mica, and muscovite is the potassic white mica. Sometimes mica is used as a lost-circulation material in drilling.

Mill n: a downhole tool having rough, sharp, and extremely hard cutting surfaces for removing metal by grinding or cutting. Mills are run on drill pipe or tubing and are used for such purposes as grinding up debris in the hole, removing stuck portions of drill stem, removing sections of casing for sidetracking, and reaming out tight spots in casing. They are variously termed junk mills, reaming mills, etc., according to the use for which they were designed.

Millidarcy (md) n: one thousandth of a darcy. (See darcy.)

Mineral rights n: the rights of ownership, conveyed by deed, of gas, oil, and other minerals beneath the surface. In the United States, the mineral rights are the property of the surface owner unless disposed of separately.

Miscible drive n: a method of enhanced recovery in which various hydrocarbon solvents or gases (as propane, LPG, natural gas, or a mixture thereof) are injected into the reservoir to reduce interfacial forces between oil and water in the pore channels and thus displace oil from the reservoir rock.

Mist drilling n: a drilling technique that uses air or gas (to which a foaming agent has been added) as a circulation medium.

Mix mud v: to prepare drilling fluids from a mixture of water or other fluids and one or more of the various dry, mud-making materials (as clay, weighting material, chemicals, etc.).

Molecular weight n: the sum of the atomic weights in a molecule. For example, the molecular weight of water, $H_2O$ is 18 because the atomic weight of hydrogen is 1 and the atomic weight of oxygen is 16. There are two atoms of hydrogen ($H_2$) and one atom of oxygen (O) in one molecule of water ($H_2O$); thus, 2 plus 16 equals 18.

Mole percent n: the ratio of the number of moles of one substance to the total number of moles in a mixture of substances multiplied by 100 to put the number on a percentage basis.

Monocline n: rock strata that dip in one direction only. Compare with anticline and syncline.

Montmorillonite n: a clay mineral often used as an additive to a drilling mud. It is a hydrous aluminum silicate capable of reacting with such substances as magnesium and calcium. For its use and properties, refer to bentonite.

Mud additive n: any material added to drilling fluid to change some of its characteristics or properties.

Mud cake n: the sheath of mud solids that forms on the wall of the well when the liquid from the mud filters into the formation; also called wall cake or filter cake.

Mud engineer n: a specialist in drilling fluids, who has knowlegde of chemistry, engineering, and the behavior of drilling fluids.

Mud log n: a record of information derived from examination of drilling fluid and drill-bit cuttings. (See mud logging.)

Mud logger n: an employee of a mud-logging company who keeps the mud log.

Mud logging n: the recording of information derived from examination and analysis of mud circulated out of the hole and drill-bit cuttings. A portion of the mud is diverted through a gas-detecting device and examined further under untraviolet light for the purpose of detecting the presence of oil or gas. Mud logging is often carried out in a portable laboratory set up at the well.

Mud pit n: the reservoir or tank, usually made of steel plates, through which the drilling mud is cycled to allow sand and fine sediments to settle out, where additives are mixed with mud, and where the fluid is temporarily stored before being pumped back into the well. Mud pits may be further classified as shaker pits, settling pits, and suction pits, according to their main purposes.

Mud up v: to add solid materials (as bentomite or other clay) to a drilling fluid that is composed mainly of clear water. The addition of clay gives the drilling fluid certain desirable properties that clear water alone does not have.

Naphthene-base oil n: a crude oil that, when compared with paraffin-base oils, is characterized by a low API gravity and a low yield of lubricating oils having a low pour point and a low viscosity index. This is often called asphalt-base oil because the residue from its distillation contains asphaltic materials but little or no paraffin wax.

Naphthene series n: the saturated hydrocarbon compounds of the general formula $C_nH_{2n}$ (as ethylene or ethene, $C_2H_4$). (See hydrocarbons.)

Newtonian fluid n: a fluid in which the viscosity remains constant for all rates of shear provided constant conditions of temperature and pressure are maintained. Most drilling fluids behave as nonNewtonian fluids in that their viscosity is not constant but varies with the rate of shear.

Nonporous adj: descriptive of a substance (as in a subsurface formation) that contains no interstices; descriptive of having no pores.

Normal circulation: the circulation of drilling fluid in a normal manner (i.e., the fluid is pumped into and down the drill stem, exists at the bit, and returns to the surface through the annular space between the pipe and the hole.) (See mud circulation and reverse circulation.)

O&G abbr: the abbreviation for oil and gas; used in drilling reports.

Odorant n: a chemical, usually a mercaptan, that is added to natural gas so that the presence of the gas can be detected by smell.

Offset well n: a well drilled on a tract of land proximate to another owner's tract on which there is a producing well.

Offshore drilling n: the drilling for oil in the waters of a sea or large lake. Drilling units for offshore operations may be a mobile, floating vessel with a ship or barge hull, a semisubmersible or submersible base, a self-propelled or towed structure with jacking legs (jack-up drilling rig), or a permanent structure that is used as a production platform when drilling is completed. In general, wildcat wells are drilled from mobile, floating vessels (as semisubmersible drilling rigs and drill ships) or from jack-up drilling rigs, while development wells are drilled from platforms.

Oil-base mud n: an oil mud that contains from less than 2 percent up to 5 percent water. The water is spread out, or dispersed, in the oil as small droplets. (See oil mud and invert-oil mud.)

Oil-cut adj: descriptive of the presence of oil in a liquid (as oil-cut mud recovered in a drill-stem test).

Oil in place n: the amount of crude oil that is estimated to exist in a reservoir and that has not been produced.

Oil patch n: a colloquial expression for an oil field. If one goes to an oil field, then one goes to the oil patch.

Oil-wet rock n: (See wettability.)

Oil zone n: a formation or horizon of a well from which oil may be produced. In any given reservoir, the oil zone is usually immediately under the gas zone and on top of the water zone if all three fluids are present and segregated.

Oolite n: a spherical or ellipsoidal particle of sand with concentric or radial structure that is formed by the replacement or accretion of concentric layers of lime around a quartz grain. An oolitic rock is characterized by these oolites.

Open-flow test n: a test made to determine the volume of gas that will flow from a well during a given time span when all the surface control valves are wide open.

Open hole n: any wellbore in which casing has not been set.

Organic rock n: the rock material produced by plant or animal life (as coal, petroleum, limestone, etc.).

Organic theory n: a principle set forth to explain the origin of petroleum. In the organic theory, it is assumed that both the hydrogen and carbon that make up petroleum came from plants and animals that lived on land and in the sea. It is further assumed that this organic material was mostly former sea and swamp life rather than true land life and was derived from the very small rather than the larger forms of life.

Oriented core n: a core taken from a well in which the orientation of the core as it was situated in the reservoir is known.

Outcrop n: the exposed portion of a buried layer of rock that appears on the surface. The term is also used as a verb (e.g., "The Queen City sand outcrops just north of the highway").

Perm abbr: the abbreviation for permeability; used in drilling reports.

pH value n: a unit of measure of the acid or alkaline condition of a substance. A neutral solution (as pure water) has a pH of 7; acid solutions are less than 7; basic or

alkaline, solutions are above 7. It should be noted that the pH scale is a logarithmic scale; a substance with a pH of 4 is more than twice as acid as a substance with a pH of 5. Similarly, a substance with a pH of 9 is much more than twice as alkaline as a substance with a pH of 8.

Pipeline oil n: the crude oil whose BS&W content is low enough to make the oil acceptable for pipeline shipment.

Plug n: any object or device that serves to block a hole or passageway (as a cement plug in a borehole).

Polymer mud n: a drilling mud to which has been added a chemical that consists of large molecules that were formed from small molecules in repeating structural units (a polymer). Polymers increase the viscosity of the mud.

por abbr: the abbreviation for porosity or pores; used in drilling reports. (See pore.)

Pore n: an opening or space within a rock or mass of rocks, usually small in size. Pores are usually filled with some fluid (as water, oil, gas, or all three).

Porosity n: the condition of something that contains pores (as a rock formation). (See pore.)

Pozzolan n: a natural or artificial siliceous material commonly added to portland-cement mixtures to impart certain desirable properties to the mixture. Added to oil-well cements, pozzolans reduce slurry weight and viscosity, increase resistance to sulfate attack, and influence such factors as pumping time, ultimate strength, and watertightness.

Pozzolan-cement mixture n: a mixture comprising both cement and a pozzolan, either natural or artificial.

ppg abbr: the abbreviation for pounds per gallon.

ppm abbr: the abbreviation for parts per million.

Pressure n: the force per unit area that is exerted on a surface (as that exerted against the inner wall of a container or piping system by a fluid or that exerted on a wellhead by a column of gas in the well). In the United States, pressure is usually expressed in pounds per square inch (psi).

Pressure drop n: a loss of pressure because of friction as a fluid passes from an area of small volume to an area of larger volume.

Pressure gauge n: an instrument for measuring fluid pressure. A pressure gauge usually registers the difference between atmospheric pressure and the pressure of the fluid being measured by indicating the effect of such pressures on a measuring element (as a column of liquid, a bourdon tube, a weighted piston, a diaphragm, or other pressure-sensitive device).

Pressure gradient n: a scale of pressure differences in which there is a uniform variation of pressure from point to point. For example, the pressure gradient of column of water is about 0.433 psi/ft of vertical elevation (9.79 kPa/m). The normal pressure gradient in a well is equivalent to the pressure exerted at any given depth by a column of 10 percent salt water extending from that depth to the surface (i.e., 0.465 psi/ft or 10.51 kPa/m).

Pressure loss n: a reduction in the amount of force a fluid exerts against a surface, such reduction usually occurring because the fluid is moving against the surface; the amount of pressure indicated by a drill-pipe pressure gauge when drilling fluid is being circulated by the mud pump. Pressure losses occur as the fluid is circulated.

Pressure maintenance n: a method for increasing ultimate oil recovery by injecting gas, water, or other fluids into the reservoir before reservoir pressure has dropped appreciably, usually early in the life of the field, to reduce or eliminate a decline in pressure.

Primary recovery n: the oil production in which only existing natural energy sources in the reservoir provide for movement of the well fluids to the wellbore.

psi abbr: the abbreviation for pounds per square inch.

psia abbr: the abbreviation for pounds per square inch absolute. Psia is equal to the gauge pressure plus the pressure of the atmosphere at that point.

psi/ft abbr: the abbreviation for pounds per square inch per foot.

psig abbr: the abbreviation for pounds per square inch gauge. Psig is the pressure in a vessel or container as registered on a pressure gauge attached to the container.

Quartz n: a hard mineral composed of silicon dioxide. Quartz is a common component in igneous, metamorphic, and sedimentary rocks.

Quicklime n: unslaked lime (calcium oxide). Chemical symbol is CaO.

Radial flow n: the flow of fluids into a wellbore from the surrounding drainage area.

Radioactive tracer n: a radioactive material (very often the mineral carnotite) put into a well to observe fluid or gas movements by means of a tracer survey.

Radioactivity n: the property possessed by some substances (as radium, uranium, or thorium) of releasing alpha particles, beta particles, and gamma particles as the substance spontaneously disintegrates. A substance is radioactive if it emits alpha, beta, or gamma particles.

Radioactivity well logging n: the recording of the natural or induced radioactive characteristics of subsurface formations. A radioactivity log, also known as a radiation log, normally consists of two recorded curves: a gamma-ray curve and a neutron curve. Both give an indication of the types of rocks and the types of fluids contained in the rocks. The two logs may be run simultaneously and in conjunction with a collar locator in a cased or uncased hole.

Red bed n: any layer of sedimentary rock that is predominantly red in color. Sometimes the term is applied specifically to rocks of the Permian and Triassic ages only.

Red-lime mud n: a clay, water-base mud containing caustic soda and tannates to which lime has been added.

Reef n: a type of reservoir trap composed of rock (usually limestone) formed from the bodies of marine plants or animals; a buried coral or other reef from which it is hoped that hydrocarbons can be withdrawn.

Relative permeability n: the effective permeability divided by the absolute permeability. When a rock is saturated with more than one fluid, relative permeability is used to express the permeability of the rock to each fluid.

Reserve pit n: originally, a mud pit in which a reserve supply of drilling fluid was stored. Now the reserve pit is actually used as a waste pit and is usually an excavated, earthen-walled pit. If necessary, it may be lined with plastic to prevent contamination of the soil.

Resistivity n: the electrical resistance offered to the passage of current; the opposite of conductivity.

Retarder n: a chemical compound (as gypsum, lime, sodium tannate, etc.) that is used to prolong the thickening,

or hardening time of oil-well cements; the opposite of an accelerator, which is added to reduce the setting time. (See cementing materials.)

Reverse circulation n: the return of drilling fluid through the drill stem. The normal course of drilling-fluid circulation is downward through the drill stem and upward through the annular space surrounding the drill stem. For special problems, normal circulation is sometimes reversed, and the fluid returns to the surface through the drill stem, or tubing, after being pumped down the annulus.

Rig up v: to prepare the drilling rig for making hole. Before the work of drilling can be started but after the derrick has been built or the mast erected, tools and machinery must be installed. This operation, which in substance is that of getting the rig ready, is conveniently described by the driller's term of rigging up.

Rock n: an aggregate of different minerals. Rocks are divided into three groups on the basis of their mode of origin: igneous, metamorphic, and sedimentary.

Rock hound n; a geologist (slang).

Rotary drilling n: the drilling method by which a hole is drilled by a rotating bit to which a downward force is applied. The bit is fastened to and rotated by the drill stem, which also provides a passageway through which the drilling fluid is circulated. Additional joints of drill pipe are added as drilling progresses.

Rotary table n: the principal component of a rotary, or rotary machine: used to turn the drill stem and support the drilling assembly. It features a beveled-gear arrangement to create the rotational motion and an opening into which bushings are fitted to drive and support the drilling assembly.

Roughneck n: a workman on a drilling or workover rig, subordinate to the driller. Sometimes he is called a rotary helper, floorman, or rig crewman.

Round trip n: the action of pulling out and subsequently running back into the hole a string of drill pipe or tubing; also called tripping the pipe.

Roustabout n: a laborer who assists the foreman in the general work about producing oil wells and around the property of the oil company; the helper who works on a well-servicing unit; the helper who does utility work on an offshore drilling rig.

rpm abbr: the abbreviation for revolutions per minute.

Sack (sx) n: a volume measure. Cement, bentonite, and ilmenite are marketed in sacks (bags) containing the following amounts

| | |
|---|---|
| Cement | 94 lb (1 cu ft) |
| Bentonite | 100 lb |
| Ilmenite | 100 lb |
| Barite | 100 lb |

Salt n: a compound that is formed (along with water) by the reaction of an acid with a base. A common salt is sodium chloride, NaCl. This can be derived by combining hydrochloric acid, HCl, with sodium hydroxide, NaOH; the result is sodium chloride, NaCl, and water, $H_2O$. This process is written chemically as $HCl + NaOH \rightarrow NaCl + H_2O$. Another salt, for example, is calcium sulfate, $CaSO_4$, obtained when sulfuric acid, $H_2SO_4$, is combined with calcium hydroxide, $Ca(OH)_2$.

Salt dome n: a dome that is caused by an intrusion of rock salt into overlying sediments. A piercement salt dome is one that has been pushed up so as to penetrate the overlying sediments, leaving them truncated. The formations above the salt plug are usually arched so that they dip in all directions away from the center of the dome, thus frequently forming traps for petroleum accumulations.

Salt water n: a water that contains a large quantity of a salt (e.g., sodium chloride) dissolved in it; brine.

Sample log n: a graphic representation of the rock formations penetrated by drilling that is prepared by the geologist from samples and cores.

Sampler n: a device attached to a flow line to take continuous samples of the oil or gas flowing in the line.

Samples n pl: the well cuttings obtained at definite footage intervals during drilling. From an examination of these cuttings, the geologist determines the rock type, the formation being drilled, the formation tops, and the indications of oil and/or gas content. Also, small quantities of well fluids that are obtained for analysis are samples.

Sampling n: the taking of a representative sample of fluid from a tank in order to measure the temperature, specific gravity, and BS&W content.

Sand n: a loose material most commonly composed of small quartz grains formed from the disintegration of preexisting rocks. Sand consists of particles less than 2 mm and greater than 1/16 mm in diameter. The term is also used when referring to a sandstone formation. (See sandstone.)

Sand consolidation n: any one of several methods by which loose, unconsolidated grains of a producing formation are caused to adhere together in order to prevent a well from producing sand yet still allow oil or gas to be produced.

Sand lens n: (See lens.)

Sandstone n: a detrital, sedimentary rock consisting of individual grains of sand (commonly composed of quartz) cemented together by silica, calcium carbonate, iron oxide, etc. Sandstone is a common rock in which petroleum and water accumulate.

Saybolt viscometer n: an instrument used for measuring the viscosity of fluids that consists basically of a container with a hole or jet of a standard size in the bottom. The time required for the flow of a specific volume of fluid is recorded in seconds at three different temperatures (100 F, 130 F, and 210 F), is referred to as the Saybolt viscosity, and is written as Saybolt second universal (SSU).

Schlumberger n: the name of one of the pioneer companies in electric well logging. It is derived from the name of the French scientist who first developed the method. Around drilling rigs throughout the country, it is pronounced "slumberjay." Today, there are many companies that provide logging services of all kinds (as Welex, Baroid, etc.).

sd abbr: the abbreviation for sand or sandstone, used in drilling reports.

sdy abbr: the abbreviation for sandy; used in drilling reports.

seat n: that point in the wellbore where casing is set.

Sediment n: the matter that settles to the bottom of a liquid; tank bottoms, basic sediment, etc. Buried layers of sedimentary rock are often referred to as sediments.

Sedimentary rock n: a rock composed of materials that were transported to their present position by wind or water. Sandstone, shale, and limestone are sedimentary rocks.

Seismograph n: a device for detecting vibrations in the earth. It is used in prospecting for probable oil-bearing structures. In this application, the vibrations are created by discharging explosives in shallow boreholes or by striking the surface with a heavy blow. The nature and velocity of the vibrations as recorded by the seismorgraph indicate the general nature of the section of earth through which the vibrations pass.

Self-potential (SP) n: one of the natural electrical characteristics exhibited by a formation as measured by a logging tool lowered into the wellbore. It is also referred to as a spontaneous potential and is one of the basic curves obtained by an electrical well log.

Set casing v: to run and cement casing at a certain depth in the wellbore; also called to set pipe.

Set pipe v (See set casing.)

SG abbr: the abbreviation for show of gas; used in drilling reports.

sh abbr: the abbreviation for shale; used in drilling reports.

Shake out v: to spin a sample of oil at high speed, usually in a centrifuge, to determine its BS&W content, which settles out due to centrifugal force.

Shale n: a fine-grained sedimentary rock composed of silt and clay-sized particles. It ranges in composition from pure clays to calcareous or siliceous clays. Shale is the most frequently occurring sedimentary rock.

Shale shaker n: a series of vibrating trays with sieves that remove cuttings from the circulation fluid in rotary drilling operations. The size of the openings in the sieve is carefully selected to match the solids content of the drilling fluid and the size of cuttings that are expected. Also called a shaker.

Shoestring sand n: a long, narrow sand deposit, usually a buried sandbar or filled channel.

Show n: an appearance of oil or gas in the cuttings, samples, cores, etc., of a drilling well.

Shut down v: to temporarily stop work or to temporarily stop a machine or operation.

SIBHP abbr: the abbreviation for shut-in bottom-hole pressure; used in drilling reports.

SICP abbr: the abbreviation for shut-in casing pressure; used in drilling reports.

Sidewall coring n: a coring technique in which core samples are obtained from a zone that has already been drilled. In this technique, a hollow bullet is fired into the formation wall, capturing the core. It is retrived on a flexible-steel cable. Core samples of this type normally range from 3/4 to 1 3/16 in. in diameter and from 3/4 to 1 in. in length. This method finds particular application in soft-rock areas.

Skin effect n: (See skin.)

Sloughing n: (See caving.) In the oil industry, sloughing is pronounced "sluffing."

Slugging compound n: a special chemical demulsifier that is often added to the emulsion samples in order to determine the total amount of sediment and water in the samples; also called knockout drops.

Slurry n: a plastic mixture of portland cement and water that is pumped into the well to harden, after which it supports the casing and provides a seal in the wellbore tc prevent migration of underground fluids.

Slurry viscosity n: the consistency of a slurry measured in poise.

Slurry volume n: the sum of the absolute volumes of solids and liquids that constitute a slurry.

Slurry weight n: the density of a cement slurry expressed in pounds per gallon (ppg), pounds per cubic foot (lb/ft ), kilograms per liter (kg/liter), etc.

Slurry yield n: the volume of slurry obtained when one sack of cement (94 lb) is mixed with the desired amount of water and any other additives (as accelerators, fluid-loss control agents, etc.)

Slush pit n: the mud pit in which rotary drilling cuttings are separated from the mud stream, mud is treated by means of additives, or mud is temporarily stored before being pumped back into the well. Modern rotary drilling rigs are generally provided with three or more pits, which usually are fabricated-steel tanks fitted with built-in piping, valves, and mud agitators.

SNG abbr: the abbreviation for synthetic, or substitute, natural gas. (See synthetic (substitute) natural gas.)

SO&G abbr: the abbreviation for show of oil and gas; used in drilling reports.

SO&W abbr: the abbreviation for show of oil and water; used in drilling reports.

Sodium chloride n: a common table salt. Sometimes sodium chloride is used in cement slurries as an accelerator or a retarder, depending on the concentration. Chemical symbol is NaCl.

Solution n: a uniform mixture of two or more substances. The dissolved substance is referred to as the solute, and the substance in which the solute is dissolved is termed the solvent.

Solution gas n: the lighter hydrocarbons that exist as a liquid under reservoir conditions but that change to a gas when the reservoir is produced. (See solution-gas drive.)

Solution-gas drive n: a source of natural reservoir energy in which the lighter hydrocarbon components that exist as a liquid in the reservoir before it is produced come out in the form of gas as the reservoir is produced. The solution gas coming out of the oil expands to force the oil into the wellbore.

Solution-gas-oil ratio n: (See gas-oil ratio.)

Sonic logging n: the recording of the time required for a sound wave to travel a specific distance through a formation. The difference in observed travel times are due mainly to variations in porosities of the medium. Other determinations made from the sonic log are based largely on its ability to distinguish between porous and non-porous formations. The sonic log may be run simultaneously with a spontaneous-potential log or with a gamma-ray log. It is useful for correlation purposes and often is used in conjunction with other logging services for substantiation of porosities. It is run in an uncased hole.

Sour adj: descriptive of that which contains or is caused by hydrogen sulfide or other sulfur compounds.

Sout gas n: a natural gas containing hydrogen sulfide.

SP abbr: the abbreviation for self-potential or spontaneous potential.

Spacing n: (See well spacing.)

spd abbr: the abbreviation for spudded; used in drilling reports.

Spontaneous potential (SP) n: One of the basic electric-logging curves obtained by measuring natural earth currents. Also called self-potential; usually referred to by the initials SP.

Spud v: to move the drill stem up and down in the hole over a short distance without rotation. Careless execution of this operation creates pressure surges that can cause a formation to break down, which results in lost circulation. (See spud in.)

Spudder n: a portable cable-tool drilling rig, which may be mounted on a truck or trailer.

ss abbr: the abbreviation for sand or sandstone; used in drilling reports.

SSO abbr: the abbreviation for slight show of oil; used in drilling reports.

Stake a well v: to precisely locate the point on the surface at which the well is to be drilled. After exploration techniques have revealed the possibility of the existence of a subsurface, hydrocarbon-bearing formation, a certified and registered land surveyor drives a stake into the ground to mark the point where the hole is to be drilled.

Static fluid level n: the level to which fluid rises in a well when the well is shut in.

Static pressure n: the force exerted by a fluid at rest and confined within a tank or line as measured by a gauge.

Straddle packer n: two packers separated by a spacer of appropriate length. A straddle packer may be used for isolating sections of open hole to be treated or tested or for isolating certain areas of perforated casing from the rest of the perforated section. (See packer.)

Straight hole n: a hole that is drilled vertically or nearly vertically, usually such that no part of the hole is more than 3 degrees off vertical per 100 ft of hole.

Strap in v: to measure the length of pipe as it is run into the hole.

Strata n pl: distinct, generally parallel beds of rock. An individual bed is called a stratum; several beds are called strata.

Stratification n: the natural layering or limination characteristic of sediments and sedimentary rocks. (See strata.)

Stratigraphic test n: (See strat test.)

Stratigraphic trap n: a hydrocarbon trap that is caused by either the fact that the top of the reservoir bed is terminated by other beds or by a change of porosity or permeability within the reservoir bed itself. Compare with structural trap. (See trap.)

Stratigraphy n: a branch of geology concerned with the study of the origin, composition, distribution, and succession of rock strata.

Strat test n: a well that is drilled primarily to obtain geological information and that is usually not completed even if commercial quantities of petroleum are found.

Stratum n: the singular form of strata.

Structural trap n: a hydrocarbon trap in which the trap is formed because of deformation (as folding or faulting) of the rock layer that contains the hydrocarbons (e.g., an anticlinal trap). Compare with stratigraphic trap. (See trap.)

Structure n: a geologic term that refers to the rock formation of interest. For example, a particular well could be referred to as on the edge of the structure, meaning that the wellbore penetrates the reservoir near its periphery.

Stuck pipe n: the drill pipe, drill collars, casing, or tubing that has inadvertently become immobile in the hole. Sticking may occur while drilling is in progress, while casing is being run in the hole, or while the drill pipe is being hoisted.

Stuck point n: the depth in the hole at which the drill stem, tubing, or casing is stuck.

Substructure n: the foundations on which the derrick and engines sit, containing space for storage and well control equipment.

Subsurface adj: descriptive of that which is below the surface of the ground (as subsurface formations, etc.).

Subsurface geology n: the study of rocks that lie beneath the surface of the earth.

Suitcase sand n: a formation that has been found to be nonproductive of oil and gas. The name is derived from the

fact that, when such a formation is encountered, operations are suspended, and the crews pack their suitcases and move to another job.

Surface pipe n: the first string of casing to be set in a well. The length varies in different areas from a few hundred feet to three or four thousand feet. Some states require a minimum length to protect freshwater sands. On some wells it is necessary to set a temporary conductor pipe, which should not be confused with the surface pipe as described here.

Surface pressure n: the pressure measured at the wellhead.

Surfactant n: a substance that affects the properties of the surface of a liquid or solid by concentrating in the surface layer. Surfactants are useful in that they can ensure that the surface of one substance or object is put in thorough contact with the surface of another substance.

Surfactant mud n: a drilling mud prepared by adding a surfactant to a water-base mud, which changes the colloidal state of the clays from that of complete dispersion to one of controlled flocculation. These muds were originally designed for use in deep, high-temperature wells, but their many advantages (high chemical and thermal stability, minimum swelling effect on clay-bearing zones, lower plastic viscosity, etc.) may extend their applicability.

Surge n: the motion of a mobile, offshore drilling rig in a direction in line with the center line of the rig; especially the front-to-back motion of the rig when it is moored in a seaway.

Surge effect n: a rapid increase in pressure downhole that occurs when the drill stem is lowered rapidly or when the mud pump is rapidly brought up to speed after starting.

Survey n: (See directional survey.)

Swab n: a rubber-faced, hollow cylinder mounted on a hollow mandrel with a pin joint on the upper end to connect to the swab line. A check valve that opens upward on the lower end provides a means of removing fluid from the well when pressure is insufficient to support flow. (See swab.)

Sweet crude oil n: oil containing little or no sulfur, especially in the form of hydrogen sulfide.

Sweet gas n: a natural gas containing little or no hydrogen sulfide.

T abbr: the abbreviation for top of; used in drilling reports.

TA abbr: the abbreviation for temporarily abandoned.

Tag v: to touch an object downhole with the drill stem (as to tag bottom (of the hole) or to tag the top of the fish).

Tally v: to measure and record the total length of pipe, casing, or tubing that is to be run in a well.

Tar sand n: a sandstone that contains mostly very heavy, tar-like hydrocarbons. Tar sands are difficult to produce by ordinary methods; thus, it is costly to obtain usable hydrocarbons from them.

Temperature n: a measure of heat or the absence thereof, usually expressed as degrees Fahrenheit or centigrade. Degrees centigrade is the standard in countries where the metric system is employed.

Temperature gradient n: the rate of change of temperature with displacement in a given direction. As the depth of a well increases, so does the temperature; this phenomenon is known as the temperature gradient.

Terminal n: a point to which oil is transported through pipelines. It usually includes a tank farm and may include tanker-loading facilities.

Tertiary recovery n: a recovery method employed to remove additional hydrocarbons after secondary recovery methods have been applied to a reservoir. It is sometimes possible to recover still more hydrocarbons by injecting liquids or gases (usually different from those used in secondary recovery and applied with different techniques) into the reservoir. (See secondary recovery and enhanced recovery.)

Thermal Decay Time (TDT) Log n: the brand name for a type of pulsed-neutron survey.

Thickening time n: the length of time a slurry is pumpable; time to 100 poises is measured on the consistometer; also called pumping time. (See pumpability.)

Thief n: a device that is lowered into a tank to take an oil sample at any desired depth. The sample subsequently will be used to determine the BS&W content of the oil in the tank.

Thief formation n: a formation that takes in drilling fluid as the fluid is circulated in the well; also called a thief sand or a thief zone. Lost circulation is caused by a thief formation.

Thief sand n: (See thief formation.)

Tight hole n: a drilling well about which the information obtained is restricted and passed only to those who may be authorized to receive the information. When a visitor approaches such a well, he will likely be told to keep his distance because "This is a tight hole."

Tool pusher n: the supervisor of a rotary drilling or work-over rig; a drilling foreman. Sometimes called the rig superintendent.

TP abbr: the abbreviation for tubing pressure; used in drilling reports.

Tracer survey n: a special radioactivity survey used in an oil well to obtain a reading of radioactivity from a quantity of special material injected into the well for that purpose. Radioactive tracers may be gas, liquid, or solid materials. (see tracer.)

Trap n: the layers of buried rock strata that are arranged such that petroleum is allowed to accumulate. (See structural trap and stratigraphic trap.)

Traveling block n: an arrangement of pulleys, or sheaves, through which drilling cable is reeved and that moves up and down in the derrick or mast. (See block and crown block.)

Treat n: to subject a substance to a process or chemical reagent in order to improve its quality or remove a contaminant.

Trip n: (See make a trip.)

Trip gas n: an accumulation of gas, usually a negligible amount, that enters the hole while a trip is being made.

Trip in v: (See go in the hole.)

Trip out v: (See come out of the hole.)

Turbulent flow n: the flow of a fluid in an erratic, non-linear motion as a result of high velocities.

Unconformity n: a lack of continuity in deposition between rock strata in contact with one another that corresponds to a gap in the stratigraphic record; the surface of contact between rock beds in which there is a discontinuity in the ages of the rocks. (See angular unconformity and disconformity.)

Unconsolidated sandstone n: a sand formation in which the individual grains comprising the formation do not adhere to one another. If an unconsolidated sandstone produces oil or gas, it will likely produce sand as well if not controlled by corrective measures. (See sand control and sand consolidation.)

Viscometer n: a device used for determining the viscosity of a substance; also referred to as a viscosimeter.

Viscosity n: a measure of the resistance of a liquid to flow, such resistance being brought about by the internal friction resulting from the combined effects of cohesion and adhesion. The viscosity of petroleum products is commonly expressed in terms of the time required for a specific volume of the liquid to flow through an orifice of a specific size.

Viscosity index n: an index used to establish the tendency of an oil to thin out at increasing temperatures, using as reference oils a highly paraffinic Pennsylvania oil as 100 and a Gulf Coast naphthenic oil as o.

Voids n pl: the open places in a rock that do not contain solid material but may contain fluids.

Volatile adj: descriptive of liquids that vaporize readily. (See vapor and vaporization.)

Volumetric efficiency n: the actual volume of fluid delivered by a pump divided by the volume displaced by a piston or other device on the pump, generally expressed as a percentage.

Vug n: a cavity in a rock.

Vugular formation n: a rock formation that contains vugs.

Vugular porosity n: a secondary rock porosity formed by the dissolving of more soluble portions of the rock in waters containing carbonic and other acids.

Wall cake n: (See filter cake.)

Wall hook n: a device that is used in fishing for drill pipe. If the upper end of the lost pipe is leaning against the side of the wellbore, the wall hook centers it in the hole so that it may be recovered with an overshot, which is run on the fishing string and attached to the wall hook.

Washout n: an excessive wellbore enlargement caused by solvent and erosional action of the drilling fluid; a fluid-cut opening caused by fluid leakage.

Watered out adj: descriptive of a well that has gone to water.

Water encroachment n: the movement of water into a producing formation as that formation is depleted of oil and gas by production.

Water table n: the underground level at which water is found; this term is often used in connection with underground water supplies used for irrigation and industrial plants. Also, the top of the drilling derrick or mast that supports the crown block.

Well logging n: the recording of information about subsurface geologic formations. Logging methods include records kept by the driller, mud and cutting analyses, core analysis, drill-stem tests, and electric and radioactivity procedures. (See electrical well log, mud logging, radioactivity well logging, and sonic logging.)

Wetting n: the adhesion of a liquid to the surface of a solid.

Whipstock n: a long, steel casting using an inclined plane to cause the bit to deflect from the original borehole at a slight angle. Whipstocks are used in controlled directional drilling, for straightening crooked boreholes, and for sidetracking in order to avoid unretrieved fish.

Wildcat n: a well drilled in an area where no oil or gas production exists. With present-day exploration methods and equipment, about one wildcat out of every nine drilled proves to be productive although not necessarily profitable. In nautical usage, a geared sheave of a windlass that is used for pulling anchor chain.

Wild well n: a well that has blown out of control and from which oil, water, and/or gas is escaping to the surface with great force; a gusher.

WOC abbr: the abbreviation for waiting on cement; used in drilling reports.

WOR abbr: the abbreviation for water-oil ratio.

PRODUCTION SECRETARY

## PRODUCTION SECRETARY

You have just been hired as a Production Secretary for an oil company. You are told that you will be working for the Manager of the Production Department and you will be the Production Clerk. The Geological Department has advised you the Company has just completed their Federal No. 1 as a producer of oil and gas, and the well is being turned over to Production. What do you do now?

1. Secure Authority to Produce

All production in New Mexico, whether it be located on federal, state or fee lands, is under the jurisdiction of the New Mexico Oil Conservation Commission. New Mexico Laws 1975, Chapter 289, Section 20, provides further that every producer shall notify the Energy Resources Board of the completion of a well capable of producing oil, natural gas or liquid hydrocarbon individually, or any combination thereof. This form must be filed within five (5) days of completion of the well, and contain information as outlined in Exhibit "A". You must also file a Form C-104, Authorization To Transport Oil and Natural Gas (Exhibit "B"), assuming a Form C-116 (Exhibit "B-1") has already been filed by the Geological Department. A Production Unit Number will be needed for reports made to the Oil and Gas Accounting Commission. This number will be assigned you when you have filed an Information on Producing Properties form (Exhibit "C").

2. Set Up Necessary Files

The company production superintendent will begin sending daily production sheets for this well. Information from these sheets must be tabulated to show daily production of oil, gas, water, actual days produced, days shutdown and for what reason, sales to the oil and gas purchasers, and any other information your Production Manager deems necessary. As Production Clerk you will also need files for the forms to be filed with the Oil Conservation Commission, Oil and Gas Accounting Commission, and the United States Geological Survey. It will be most helpful to secure a copy of the State of New Mexico Oil Conservation Rules and Regulations. This contains all Rules governing production, as well as drilling and abandonment of wells. When ordering your copy of these Rules you should ask to be placed on the mailing list in order that you might receive updates and changes in the Rules as they occur. The Production Manager may want a "thumb-nail" history of the well for his easy reference, and along these lines may dictate a short resume of the well completion, noting any special characteristics of the well (Exhibit "D").

3. Begin Filing Forms

The various forms have various due dates. The date most often adhered to is the 25th of the month following the month for which production is being reported. This is the due date of Form C-115 (Exhibit "E"), and because failure to file this form in a timely manner can result in loss of allowable, with resulting inability to produce a well, this is vitally important. Information needed

to complete this form will be taken from your files, as well as run tickets and statements of account furnished you by the oil and gas purchasers (Exhibits "E-1", "E-2", and "E-3"). Exhibits "F" through "I" are forms you will be required to file on this well each month. As you can see, our Federal No. 1 is a fairly uncomplicated well. Others may require more additional information. Exhibit "J" contains a list of Reports required by the Oil Conservation Commission. Any of these Reports may become due from time to time on wells which your Company operates.

Add to the new well the 100 other wells New Mexico Oil Company operates in the State of New Mexico, and you can readily see that your job as a Production Secretary will be very busy, interesting, complex and, hopefully, rewarding.

EXHIBIT "A"

Memo No. 2-75
June 16, 1975

OIL CONSERVATION COMMISSION
POST OFFICE BOX 2088
SANTA FE, NEW MEXICO
87501

M E M O R A N D U M

TO: ALL OPERATORS

FROM: JOE D. RAMEY, SECRETARY-DIRECTOR

SUBJECT: COMPLIANCE WITH PROVISIONS OF THE ENERGY RESOURCES ACT

Gentlemen:

New Mexico Laws 1975, Chapter 289, Section 20, states:

Every producer shall notify the energy resources board of:

A. the completion of a well capable of producing oil, natural gas or liquid hydrocarbon individually, or any combination thereof, or geothermal energy in commercial quantities, with sufficient detail to allow the board to suggest a manner in which the products could be used in furtherance of its statewide plan, within five days after completion of the well, and not less than five days before the producer enters into a binding agreement for, or otherwise provides for the disposition of, the products or geothermal energy of the well under an agreement or disposition which covers any period longer than six months; or

B. his intent to enter into a binding agreement covering the disposition of the products or geothermal energy of a potential well or series of wells at least five days before he enters into the agreement.

The effective date of these requirements is July 1, 1975.

EXHIBIT "B-1"

NEW MEXICO OIL CONSERVATION COMMISSION

GAS - OIL RATIO TESTS

C-116
Revised 1-1-65

| Operator | Pool | County |
|---|---|---|
| New Mexico Oil Company | Sulimar Queen | Chaves |

| Address | TYPE OF TEST - (X) | Scheduled ☐ | Completion ☒ | Special ☐ |
|---|---|---|---|---|
| P. O. Box 123, Roswell, New Mexico 88201 | | | | |

| LEASE NAME | WELL NO. | LOCATION U | S | T | R | DATE OF TEST | STATUS | CHOKE SIZE | TBG. PRESS. | DAILY ALLOWABLE | LENGTH OF TEST HOURS | PROD. DURING TEST WATER BBLS. | GRAV. OIL | OIL BBLS. | GAS M.C.F. | GAS - OIL RATIO CU.FT./BBL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Federal | 1 | M | 24 | 15S | 29E | 2/01/78 | P | 2" | 30 | 100 | 24 | 15 | 28 | 86 | 26 | 302/1 |

No well will be assigned an allowable greater than the amount of oil produced on the official test.

During gas-oil ratio test, each well shall be produced at a rate not exceeding the top unit allowable for the pool in which well is located by more than 25 percent. Operator is encouraged to take advantage of this 25 percent tolerance in order that well can be assigned increased allowables when authorized by the Commission.

Gas volumes must be reported in MCF measured at a pressure base of 15.025 psia and a temperature of 60° F. Specific gravity base will be 0.60.

Report casing pressure in lieu of tubing pressure for any well producing through casing.

Mail original and one copy of this report to the district office of the New Mexico Oil Conservation Commission in accordance with Rule 301 and appropriate pool rules.

I hereby certify that the above information is true and complete to the best of my knowledge and belief.

Operator
(Signature)

(Title)

February 3, 1978
(Date)

# EXHIBIT "B"

| NO. OF COPIES RECEIVED | | | |
|---|---|---|---|
| DISTRIBUTION | | | |
| SANTA FE | | | |
| FILE | | | |
| U.S.G.S. | | | |
| LAND OFFICE | | | |
| TRANSPORTER | OIL | | |
| | GAS | | |
| OPERATOR | | | |
| PRORATION OFFICE | | | |

NEW MEXICO OIL CONSERVATION COMMISSION
REQUEST FOR ALLOWABLE
AND
AUTHORIZATION TO TRANSPORT OIL AND NATURAL GAS

Form C-104
*Supersedes Old C-104 and C-110*
Effective 1-1-65

I.

Operator: New Mexico Oil Company

Address: Post Office Box 123, Roswell, New Mexico 88201

Reason(s) for filing *(Check proper box)*
- New Well [X]
- Recompletion [ ]
- Change in Ownership [ ]
- Change in Transporter of: Oil [ ] Dry Gas [ ] Casinghead Gas [ ] Condensate [ ]

Other *(Please explain)*

If change of ownership give name and address of previous owner _____

## II. DESCRIPTION OF WELL AND LEASE

| Lease Name | Well No. | Pool Name, Including Formation | Kind of Lease (State, Federal or Fee) | Lease No. |
|---|---|---|---|---|
| Federal | 1 | Sulimar Queen | Federal | NM 1234 |

Location: Unit Letter M ; 990 Feet From The South Line and 330 Feet From The West

Line of Section 24 Township 15-South Range 29-East , NMPM, Chaves County

## III. DESIGNATION OF TRANSPORTER OF OIL AND NATURAL GAS

| Name of Authorized Transporter of Oil XX or Condensate [ ] | Address *(Give address to which approved copy of this form is to be sent)* |
|---|---|
| Navajo Refining Co., Pipeline Division | Drawer 175, Artesia, New Mexico 88210 |
| Name of Authorized Transporter of Casinghead Gas [X] or Dry Gas [ ] | Address *(Give address to which approved copy of this form is to be sent)* |
| Phillips Gas Company | Bartlesville, Oklahoma 74003 |

| If well produces oil or liquids, give location of tanks. | Unit | Sec. | Twp. | Rge. | Is gas actually connected? | When |
|---|---|---|---|---|---|---|
| | M | 24 | 15S | 29E | Yes | February 1, 1978 |

If this production is commingled with that from any other lease or pool, give commingling order number: _____

## IV. COMPLETION DATA

| Designate Type of Completion – (X) | Oil Well | Gas Well | New Well | Workover | Deepen | Plug Back | Same Res'v. | Diff. Res'v. |
|---|---|---|---|---|---|---|---|---|
| | XX | | XX | | | | | |

| Date Spudded | Date Compl. Ready to Prod. | Total Depth | P.B.T.D. |
|---|---|---|---|
| 12/20/77 | 2/01/78 | 1975' | 1973' |
| **Elevations *(DF, RKB, RT, GR, etc.)*** | **Name of Producing Formation** | **Top Oil/Gas Pay** | **Tubing Depth** |
| 3926' GR. | Queen Sand | 1955' | 1960' |
| **Perforations** | | | **Depth Casing Shoe** |
| 1955' - 1965' | | | 1974' |

### TUBING, CASING, AND CEMENTING RECORD

| HOLE SIZE | CASING & TUBING SIZE | DEPTH SET | SACKS CEMENT |
|---|---|---|---|
| 10¾" | 8-5/8" | 388' | 100 sx circ |
| 8" | 5½" | 1975' | 150 sx |
| | | | |
| | | | |

## V. TEST DATA AND REQUEST FOR ALLOWABLE

*(Test must be after recovery of total volume of load oil and must be equal to or exceed top allowable for this depth or be for full 24 hours)*

### OIL WELL

| Date First New Oil Run To Tanks | Date of Test | Producing Method *(Flow, pump, gas lift, etc.)* | |
|---|---|---|---|
| 2/01/78 | 2/01/78 | Pumping | |
| **Length of Test** | **Tubing Pressure** | **Casing Pressure** | **Choke Size** |
| 24 hours | 30# | 30# | 2" |
| **Actual Prod. During Test** | **Oil - Bbls.** | **Water - Bbls.** | **Gas - MCF** |
| 101 | 86 | 15 | 26 |

### GAS WELL

| Actual Prod. Test - MCF/D | Length of Test | Bbls. Condensate/MMCF | Gravity of Condensate |
|---|---|---|---|
| | 101 | | |

EXHIBIT "C"

OIL AND GAS ACCOUNTING COMMISSION
P. O. Box 2308 Santa Fe, New Mexico

## INFORMATION ON PRODUCING PROPERTIES

| | Commission Use |
|---|---|
| 1. Type of request (check one): | |
| A. Assign new production unit number ..... XX | |
| B. Cancel existing production unit number (List Numbers): _____ | |
| C. Add to existing production unit number (List Numbers): _____ | |
| D. Other (Specify) _____ | |
| 2. Month products first sold (effective date of production unit number assignment) ..... February 1978 | |
| 3. Is well(s) multiple completion? ..... No | |
| If yes, how many zones are completed? ..... | |
| 4. Operator Number ..... | |
| 5. Production Unit Number ..... | |
| 6. Kind of products produced (oil, gas or both) ..... Oil & Gas | |
| 7. Lease Name Federal | |
| 8. Tract Number (if applicable) ..... | |
| 9. Information concerning location of well(s): | |
| A. County ..... Chaves | |
| B. School District (if available) ..... 16 | |
| C. Municipality (if applicable) ..... | |
| D. Is well(s) part of a unitization, communitization or authorized commingling? ..... No | |
| If yes, attach a copy of approved agreements. | |
| E. State Lease Number (if applicable) ..... | |
| F. State Land Beneficiary (if applicable) ..... | |
| G. Land type (federal, fee, state or Indian Tribe) .... Federal | |
| H. Well description: | |

* Section Subdivision by unit letter:

| | | | |
|---|---|---|---|
| D | C | B | A |
| E | F | G | H |
| L | K | J | I |
| M | N | O | P |

| Well No. | Unit* Letter | Section | Township | Range |
|---|---|---|---|---|
| 1 | M | 24 | 15S | 29E |

I. Pool Name Sulimar Queen

10. Name of oil purchaser Navajo Refining Co., Pipeline Division

11. Name of gas purchaser Phillips Gas Company 102

EXHIBIT "D"

Re: Well Completion
New Mexico Oil Company
Federal No. 1
Unit M-Sec. 24-T15S-R29E
Chaves County, New Mexico

1/16/78: Set 5½" casing at TD of 1975, cemented with 150 sx Class C cement, 2% calcium chloride. Plug down 2:00 PM. WOC.

1/17/78: Drilled plug. Cement effective. Prep to perforate.

1/18/78: Waiting on unit.

1/22/78: Ram Western Company Gamma Ray Neutron Log. Perforated 1955' to 1965' with 2 shots per foot. Fraced well with 15,000 gals. treated water, 5000# 10/20 and 10,000# 20/40 sand. 360 BLWTR (barrels load water to recover).

1/23/78: Well on vacuum this AM. Ran rods and tubing. Prep to place on pump.

1/24/78: Well placed on pump.

1/25/78: Well recovering load water, making some gas.

1/27/78: 120 BLWTR. Well making some oil and gas.

1/29/78: All load water recovered. Well still making some water.

1/31/78: Place well on 24 hour test for potential.

2/01/78: Well made 101 barrels fluid in 24 hours, 86 barrels of oil, 15 barrels of water, 26 MCF gas. Well potentialled this date.

NOTE: Have contacted chemical company for analysis and recommendations concerning foreign substances in oil production.

P. O. Box 2088, Santa Fe 87501

# OPERATOR'S MONTHLY REPORT

## EXHIBIT "E"

ORIGINAL TO OCC SANTA FE
ONE COPY TO OCC DIST. OFFICE
ONE COPY TO TRANSPORTER(S)

Form C-115
(Rev. 8-1-77)

(Company or Operator) New Mexico Oil Company (Address) P. O. Box 123, Roswell, NM (Zip) 88201 (Month, Year) 2/78 Page 1 of 1

| POOL NAME (Underline) *Lease Name WELL NO UNIT SEC TWP RNG | WELL STATUS | INJECTION VOLUME | INJECTION PRESS. | TOTAL LIQUIDS PRODUCED MONTHLY OIL ALLOWABLE | TOTAL LIQUIDS PRODUCED ACTUAL BARRELS PRODUCED | TOTAL LIQUIDS PRODUCED BARRELS OF WATER PRODUCED | GAS PRODUCED (MCF) | DAYS PROD. | DISPOSITION OF GAS SOLD | DISPOSITION OF GAS TRANSPORTER | DISPOSITION OF GAS OTHER | DISPOSITION OF GAS CODE | DISPOSITION OF OIL OIL ON HAND AT BEG. OF MONTH | DISPOSITION OF OIL BARRELS TO TRANSPORTER | DISPOSITION OF OIL TRANSPORTER | DISPOSITION OF OIL OTHER | DISPOSITION OF OIL CODE | DISPOSITION OF OIL OIL ON HAND AT END OF MONTH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *LEASE NAME - Include State Land Lease Number or Federal Lease Number | | | | | | | | | | | | | | | | | | |
| SULIMAR QUEEN | | | | | | | | | | | | | | | | | | |
| Federal No. 1 M-24-15S-29E | P | NM 1234 | | 2800 | 2184 | 420 | 728 | 28 | 728 | PP | -0- | | 0 | 1900 | NRC | 0 | | 284 |
| NOTE When additional wells are completed on this lease, it will be necessary that you have a lease total, to-wit: | | | | | | | | | | | | | | | | | | |
| N-24-15S-29E | P | | | 2800 | 2184 | 420 | 728 | 28 | 728 | | | | | | | | | |
| LEASE TOTALS: | | | | 5600 | 4368 | 840 | 1456 | 28 | 1456 | PP | 0 | | 0* | 3800 | NRC | 0 | | 284 |

*When other wells are added you will no doubt have oil on hand at beginning of month. Oil on hand at end of month plus barrels to transporter less oil on hand at beginning of month equals actual barrels produced.

101

**STATUS CODE**
F.....FLOWING
P.....PUMPING
G.....GAS LIFT
S.....SHUT IN
T.....TEMP ABANDONED
I.....INJECTION
D.....DISCONTINUED

**"OTHER" GAS DISPOSITION CODE**
X.....USED OFF LEASE } DETAIL ON FORM C-111
D.....USED FOR DRILLING }
G.....GAS LIFT
L.....LOST (MCF ESTIMATED)
E.....EXPLANATION ATTACHED
R.....REPRESSURING OR PRESSURE MAINTENANCE
V.....VENTED
U.....USED ON LEASE

**"OTHER" OIL DISPOSITION CODE**
C.....CIRCULATING OIL
L.....LOST
S.....SEDIMENTATION (BSEW)
E.....EXPLANATION ATTACHED

I HEREBY CERTIFY THAT THE INFORMATION GIVEN IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

(NAME) Operator 135
(POSITION)
March 25, 1978
(SIGNATURE) (DATE)

11-48 BAKS
REV. 9-1-64

# NAVAJO REFINING COMPANY
## Pipe Line Division
## RUN TICKET

OPERATOR

Mark McClellan

LEASE NAME

Trust 1.2.3

| MO. | DAY | YEAR | DISTRICT NO. | TICKET NO. |
|---|---|---|---|---|
| 12 | 30 | 70 | 3 | 824 |

TANK NO. 3485 | LEASE NO.

OFFICE CODES

TANK SIZE 500

| GAUGE | FT. | IN. | ½ IN. |
|---|---|---|---|
| HEIGHT OF CONNECTION | 1 | 1 | 0/4 |

| B. S. & W. LEVEL | | | |
|---|---|---|---|
| 1ST. | 0 | 4 | 0/4 |
| 2ND. | | | /4 |

| GAUGE | OIL LEVEL FT. | IN. | ½ IN. | TEMP. |
|---|---|---|---|---|
| 1ST. | 15 | 7 | 0/4 | 52 |
| 2ND. | 1 | 1 | 0/4 | 44 |

OBSERVED QTY. & TEMP. 347 52 | TRUE QTY. 347

POWER | B. S. & W. 3/10 %
TRUCK

CALCULATIONS
522.79
36.40
486.39

OIL MOVED BY PUMP ☐ GRAVITY ☐ TRUCK ☐

TO (NAME OF LINE OR STATION) Beeson | CODE

POWER FURNISHED BY OR TRUCKED BY PLCO. ☐ OTHER ☐ | CODE

TURNED ON

GAUGER D. A. Dix | TIME 9:24 M

OPERATOR'S WITNESS (OR WAIVER NO.) | OFF SEAL 265055

SHUT OFF

GAUGER D. A. Dix | TIME 10:11 DATE 12-31

OPERATOR'S WITNESS (OR WAIVER NO.) | ON SEAL 265064

REMARKS

This ticket covers all claims for allowance. The oil represented by this ticket was received and run as the property of Navajo Refining Company.

EXHIBIT "E-1"

EXHIBIT "E-2"

NAVAJO CRUDE OIL PURCHASING COMPANY

STATEMENT OF CRUDE OIL RUNS

February 1978



2/28/78

| | | NET BARRELS | GROSS VALUE | MARKETING | TAXES | NET VALUE |
|---|---|---|---|---|---|---|
| February 1978 | CURRENT MONTH | 1,900.42 | 10,167.25 | .00 | 724.46 | 9,442.79 |

| T | TANK | GVTY | NET BARRELS | LOWER TIER BARRELS | LOWER TIER $ PRICE | LOWER TIER $ VALUE | STRIPPER UPPER TIER BARRELS | STRIPPER UPPER TIER $ PRICE | STRIPPER UPPER TIER $ VALUE | TOTAL VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 10772 | | | | | | | | | |
| 6 | 10773 | | | | | | | | | |
| 6 | 10772 | | | | | | | | | |
| 3 | 10773 | | | | | | | | | |
| 6 | 10772 | | | | | | | | | |
| 1 | 10773 | | | | | | | | | |
| 1 | 10772 | | | | | | | | | |
| 0 | 10773 | | | | | | | | | |
| 6 | 10772 | | | | | | | | | |
| TICKETS | | | | | | | | | | |

THIS WILL CONTAIN BREAKDOWN INFORMATION ON EACH RUN TICKETS. TOTALS HAVE BEEN SHOWN.

1,900.42

EXHIBIT "E-3"

PAGE 1

# PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

PERIOD Feb. 1978

Form 10293/CPG A014 9-75

## GAS STATEMENT

| OPERATOR | LEASE | DUPL CODE | COUNTY | FIELD | STATE SYS LEASE-SUB |
|---|---|---|---|---|---|
| NEW MEXICO OIL COMPANY | FEDERAL NO. 1 | 007 | CHAVES | SULIMAR QUEEN | 06 81 888832 00 |

| STATUS | GAS CODE | FILE NO. | BASE | For All Meters | API Gravity | For All Meters | Total Gas Sold | Residue Price Per MCF | 6. Residue Value Due All Leases |
|---|---|---|---|---|---|---|---|---|---|
| EE | CH 472 | 000009 | 14.650 | 1,235,802 | 136.9 | 1,471,565 | 704,960 | .5258701 | |

| 7. Meter | 8. MCF Before Fav Adj. | 9. Total MCF | 10. Test Gasoline Content Per MCF | 11. Meter Station Test Gallons | 12. % Per Contract | 13. Item 11 Times Item 12 | 14. Gasoline or Oil Price | 15. Unit Price | 16. Value |
|---|---|---|---|---|---|---|---|---|---|
| 888832 | | 1,335 | 3.110 | 4,152 | | | .2550 | .4053200 | 541.10 |
| 888832 | SCHOOL + CONSERVATION TAX | | | 14.83 | SEVERANCE TAX | | 20.29 | ADVALOREM TAX | 7.65 |
| | | | | | | | | | 541.10 |

### LIQUID VALUE COMPUTATIONS

### LEASE RESIDUE COMPUTATIONS

| 17-CONTRACT RESIDUE MCF | 18-RETURN TO LEASE | 19-DIFFERENCE MCF | 20-ALLOCABLE GAS SOLD | 21-SEV TAX CALC. OI | 22-RESIDUE PAYMENT | * | BTU | VALUES ADDED FOR TAX REIMB | MIN CONTRACT |
|---|---|---|---|---|---|---|---|---|---|
| | | | 27 | VALUE | 5.50 | | | | |
| 834 | | 834 | 449 | VOLUME | 118.06 | | | 19.48 | |
| SCHOOL + CONSERVATION TAX | | | | SEVERANCE TAX | | | | ADVALOREM TAX | |
| SCHOOL + CONSERVATION TAX | | | | SEVERANCE TAX | | | | ADVALOREM TAX | |

### PAYMENT SUMMARY

| | TOTAL MCF | TOTAL VALUE | SCH + CONS TAX | SEVERANCE TAX | ADVALOREM TAX | TOTAL TAX | TOTAL VALUE LESS TAX |
|---|---|---|---|---|---|---|---|
| TAX EXEMPT SUMMARY | | | | | | | |
| TAX EXEMPT SUMMARY | 727.90 | 378.50 | | | | | |

(THESE COMPUTED TAXES WOULD BE SHOWN. ON THIS EXAMPLE ONLY GROSS MCF AND VALUE HAVE BEEN SHOWN.)

EXHIBIT "F"

**UNITED STATES**
**DEPARTMENT OF THE INTERIOR**
**GEOLOGICAL SURVEY**

Form 9-361 Rev. Feb 76
OMB 42-R0361

This report is required by law (30 U.S.C. 189, 30 U.S.C. 359, 25 U.S.C. 396 d), regulation (30 CFR 221.62), and the terms of the lease. Failure to report can result in the assessment of liquidated damages (30 CFR 221.54 (j)), shutting down operations, or basis for recommendation to cancel the lease and forfeit the bond (30 CFR 221.53).

## MONTHLY REPORT OF SALES AND ROYALTY

AMENDED REPORT ☐

See Reverse of Form For Instructions

| ON SHIP | LEASE OR CONTRACT NUMBER | SPECIAL CODE | DATE MO | DATE YR | PRODUCT CODE | ROYALTY RATE CODE | SOURCE CODE | COMPANY CODE | ROYALTY IN KIND | NUMBER OF WELLS | WELL CODE | GRAVITY, METRL., TAX, ETC., CODE | QUANTITY | ± | CODE & FOR UNIT PRICE | VALUE OR UNIT PRICE | ± | | CARD NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 001234 | | 2 | 78 | 01 | | | 537 | | | | | 1,900.42 | + | | 10,167.25 | + | NRC | 8 Y |
| 2 | | | | | | | | / | | | | | 727.90 | + | | 378.50 | + | PP | 8 Y |
| 3 | | | | | | | | | | | | | | | | | | | 8 Y |
| 4 | | | | | | | | | | | | | | | | | | | 8 Y |
| 5 | | | | | | | | | | | | | | | | | | | 8 Y |
| 6 | | | | | | | | | | | | | | | | | | | 8 Y |
| 7 | | | | | | | | | | | | | | | | | | | 8 Y |
| 8 | | | | | | | | | | | | | | | | | | | 8 Y |
| 9 | | | | | | | | | | | | | | | | | | | 8 Y |
| 10 | | | | | | | | | | | | | | | | | | | 8 Y |
| 11 | | | | | | | | | | | | | | | | | | | 8 Y |
| 12 | | | | | | | | | | | | | | | | | | | 8 Y |
| 13 | | | | | | | | | | | | | | | | | | | 8 Y |
| 14 | | | | | | | | | | | | | | | | | | | 8 Y |
| 15 | | | | | | | | | | | | | | | | | | | 8 Y |
| 16 | | | | | | | | | | | | | | | | | | | 8 Y |
| 17 | | | | | | | | | | | | | | | | | | | 8 Y |
| 18 | | | | | | | | | | | | | | | | | | | 8 Y |
| 19 | | | | | | | | | | | | | | | | | | | 8 Y |

**ACKNOWLEDGMENT**

I have read and examined the statements made herein, and find them true, correct and complete.

Signature of officer authorized to sign for lessee: Production Clerk

Telephone: 505/347-5441

Company: New Mexico Oil Company

Address: Box 123, Roswell, N. M. 88201

## INSTRUCTIONS
## (FORM 9-361)

All sales, losses or other disposition of production from Federal or Indian leases, unit participating areas and communitization agreements containing such lands must be reported monthly on Form 9-361. This report is due in the appropriate Area Office on or before the tenth day of the second month following the month of sales. Unless otherwise requested by the Area Supervisor, only one copy of Form 9-361 shall be submitted. Unless waived by the Area Supervisor, Form 9-361 must be filed each month whether or not there were any sales.

The designated operator of the lease or agreement is responsible for submitting Form 9-361 and for reporting 100 percent sales and/or losses.

Likewise, working interest owners who take their production in-kind for sale or other disposition must also submit a monthly report on Form 9-361. This report shall also show 100 percent of the sales and losses but the values shall be based on the price received by the working interest owner or the product value established by the Supervisor for such production unless otherwise instructed by the Area Office.

Form 9-361 must be submitted together with purchaser's statements or other supporting documents. When requested by the Area Office, an allocation schedule showing the lease percentages of unit production and royalty, must be attached to Form 9-361.

Instructions for completing Form 9-361 are listed below. Other information related to the submittal of Form 9-361
can be obtained by contacting any Area Oil and Gas Office.

AMENDED - Enter "X" in this block if report amends sales previously reported in error. Do not report current month's sales on amended report.

LINE NO. - Use one line for each lease, unit, or communitization agreement and each product being reported.

LEASE OR CONTRACT NO. - Enter the appropriate ADP code for the lease, unit, or communitization agreement, as assigned by the Geological Survey.

SPECIAL CODE - Enter S for reporting no sales for a given product or leave blank unless otherwise instructed.

DATE - Enter the month and year of actual sales. Current month's report must contain only sales for that month. However, amended reports may contain information for several months of a single report.

PRODUCT CODE - Enter appropriate code. The following codes shall be used. 01-Oil, 02-Condensate, 03-Dry or Residue Gas, 04-Wet Gas, 05-Distillate, 06-Gasoline, 07-LPG, 41-Oil Lost, 43-Gas Lost. When reporting a product not shown above, please contact Area Office for appropriate code.

ROYALTY RATE CODE - Leave blank unless otherwise instructed.

SOURCE CODE - Leave blank unless otherwise instructed.

COMPANY CODE - Enter the code assigned your company by each Area Office.

ROYALTY IN-KIND - If Federal or Indian royalties are being taken-in-kind enter code assigned by Area Office responsible for the account.

NUMBER OF WELLS - If lease is subject to a sliding or step-scale royalty rate enter the correct well count. 30 CFR 221.49 sets forth guidelines for determining the proper well count each month.

WELL CODE - Leave blank unless otherwise instructed.

GRAVITY, BTU'L., TAX, ETC., CODE - Enter X if the lease is subject to a sliding scale royalty and the oil is 30 BAUME°(30.7° API) or over. Otherwise leave blank unless instructed by the Area Office.

QUANTITY - Enter the sales quantity for the month. Each product shall be reported on a separate line. If a loss or disposition of oil or gas other than sales is being reported, pursuant to NTL-4 enter quantity of loss. The broken vertical line that crosses each horizontal line in this column represents a decimal. For an amended report, show a minus (-) sign and enter the quantity and other data as originally reported. On the next line enter the correct data.

CODE 9 FOR UNIT PRICE - Leave blank unless otherwise instructed.

VALUE OR UNIT PRICE - Enter the total sales value from the lease, unit participating area or communitization agreement. For an amended report, show a minus (-) sign and enter the data as originally reported. On the next line enter the correct data.

EXHIBIT "F-1"

SOUTHERN ROCKY MOUNTAIN AREA
ROSWELL, NEW MEXICO

PRODUCT CODES

| CODE NUMBERS | PRODUCT |
|---|---|
| 01 | Oil |
| 03 | Gas |
| 06 | Gasoline |
| 07 | Liquid Products |
| 09 | Sulphur |
| 11 | CO-2 |
| 15 | Helium |

EXHIBIT "F-2"

SOUTHERN ROCKY MOUNTAIN AREA
ROSWELL, NEW MEXICO

## INDIAN LEASE NUMBER PREFIX CODES

| PREFIX CODES | IDENTIFICATION | TRIBE |
|---|---|---|
| 09 | Jicarilla Cont. | Jicarilla |
| 14 | I-22-Ind | Ute Mtn & So. Ute |
| 15 | I-89-Ind | Navajo |
| 16 | I-149-Ind | Navajo |
| 19 | 14-20-151 | Ute Mtn & So. Ute |
| 20 | 14-20-600 | Navajo |
| 21 | 14-20-603 | Navajo |
| 22 | 14-20-604 | Ute Mtn & So. Ute |
| 23 | 14-20-0603 | Navajo |
| 24 | M00-C-14-20 | Ute Mtn & So. Ute |
| 25 | N00-C-14-20 | Navajo |
| 96 | SW-I | Indian Com. Agr. |

EXHIBIT "G"

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Form 9-329 Rev. Feb 76
OMB 42-R0356

MONTHLY REPORT
OF
OPERATIONS

Lease No. 29-001234

Communitization Agreement No. _____
Field Name Sulimar Queen
Unit Name _____
Participating Area _____
County Chaves State New Mexico
Operator New Mexico Oil Company

☐ Amended Report

The following is a correct report of operations and production (including status of all unplugged wells) for the month of _____, 19____

(See Reverse of Form for Instructions)

This report is required by law (30 U.S.C. 189, 30 U.S.C. 359, 25 U.S.C. 396 d), regulation (30 CFR 221.60), and the terms of the lease. Failure to report can result in the assessment of liquidated damages (30 CFR 221.54 (j)), shutting down operations, or basis for recommendation to cancel the lease and forfeit the bond (30 CFR 221.53).

| Well No. | Sec. & ¼ of ¼ | TWP | RNG | Well Status | Days Prod. | *Barrels of Oil | *MCF of Gas | *Barrels of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SW/SW | 15S | 29E | P | 28 | 2184 | 728 | 420 | |

*If none, so state.

Disposition of production (Lease, Participating Area, or Communitized Area basis)

| | Oil & Condensate (BBLS) | Gas (MCF) | Water (BBLS) |
|---|---|---|---|
| *On hand, Start of Month | 0 | XXXXXXXXXXXXXXXX | XXXXXXXXXXXXXXXX |
| *Produced | 2184 | 728 | |
| *Sold | 1900 | 728 | XXXXXXXXXXXXXXXX |
| *Spilled or Lost | 0 | XXXXXXXXXXXXXXXX | XXXXXXXXXXXXXXXX |
| *Flared or Vented | XXXXXXXXXXXXXXXX | 0 | XXXXXXXXXXXXXXXX |
| *Used on Lease | 0 | 0 | XXXXXXXXXXXXXXXX |
| *Injected | 0 | 0 | 0 |
| *Surface Pits | XXXXXXXXXXXXXXXX | XXXXXXXXXXXXXXXX | 420 |
| *Other (Identify) | 0 | 0 | 0 |
| *On hand, End of Month | 284 | XXXXXXXXXXXXXXXX | XXXXXXXXXXXXXXXX |
| *API Gravity/BTU Content | 38 | 800 | XXXXXXXXXXXXXXXX |

Authorized Signature: _____ Address: P. O. Box 123, Roswell, NM 88201

Title: Production Clerk

EXHIBIT "H"

# OIL AND GAS ACCOUNTING COMMISSION

P. O. BOX 2308 SANTA FE, NEW MEXICO

OPERATORS REMITTANCE REPORT
O-1

TAX REMITTANCE SCHEDULE

| | | |
|---|---|---|
| OIL AND GAS EMERGENCY SCHOOL TAX | (TOTAL OF COLUMN (N) OF O-2 REPORT) | $ |
| OIL AND GAS SEVERANCE TAX | (TOTAL OF COLUMN (O) OF O-2 REPORT) | |
| OIL AND GAS CONSERVATION TAX | (TOTAL OF COLUMN (P) OF O-2 REPORT) | |
| OIL AND GAS AD VALOREM PRODUCTION TAX | (TOTAL OF COLUMN (R) OF O-2 REPORT) | |
| TOTAL OF ABOVE LINES | | |
| ADD INTEREST IF REMITTANCE IS PAST DUE | | |
| ADD AMOUNT OF COMMISSION INVOICE # | | |
| DEDUCT AMOUNT OF COMMISSION CREDIT # | | ( ) |
| TOTAL TAX REMITTANCE | | $ |

MAKE CHECK PAYABLE TO: OIL AND GAS ACCOUNTING COMMISSION
ATTACH CHECK, INVOICES AND CREDITS TO THIS REPORT

STATE ROYALTY REMITTANCE SCHEDULE

| | | |
|---|---|---|
| OIL AND GAS STATE ROYALTY | (TOTAL OF COLUMN (S) OF O-2 REPORT) | $ |
| ADD AMOUNT OF COMMISSION INVOICE # | | |
| DEDUCT AMOUNT OF COMMISSION CREDIT # | | ( ) |
| TOTAL ROYALTY REMITTANCE | | $ |

MAKE CHECK PAYABLE TO: COMMISSIONER OF PUBLIC LANDS
ATTACH CHECK, INVOICES AND CREDITS TO THIS REPORT

THIS REPORT SUBMITTED BY:

COMPANY New Mexico Oil Company
ADDRESS Box 123, Roswell, NM 88201
FOR THE MONTH OF February 19 78
CONSISTING OF _____ PAGES HAS BEEN EXAMINED BY ME AND TO THE BEST OF MY KNOWLEDGE AND BELIEF IT IS TRUE, COMPLETE AND PURSUANT TO LAW AND REGULATION.

SIGNATURE _____
TITLE Production Clerk DATE 4/15/78 (Due 45 days after end of month.)

## GENERAL INSTRUCTIONS

**REPORTING PERIOD**

Each calendar month is a reporting period.

**WHO MUST REPORT**

Each operator must report monthly on forms 0-1 and 0-2. Report 0-1 is to be used to summarize remittances shown on form 0-2 and to certify the reports. *Every operator must report each of his production units each month.*

**WHO MUST REMIT TAXES AND STATE ROYALTY**

Taxes and State Royalty shall be remitted to the Commission by the operator of a production unit; however, a purchaser may, by express or implied agreement with the operator, remit taxes and State Royalty. One of the persons must remit *all* taxes and State Royalty due on an individual production unit entry.

**DUE DATE OF REPORT AND REMITTANCE**

Operators and purchasers reports and accompanying remittances are due in the Santa Fe office of the Commission within 65 days following the end of the calendar month covered by the report. There is no provision for an extension of the prescribed due date. Interest on past due taxes will be computed at the rate of one percent per month or fraction thereof.

## INSTRUCTIONS FOR FORM 0-2

**REPORT MONTH, PAGE NUMBER, COMPANY NAME**

Enter in the upper right-hand corner. Number pages in sequence.

**NO PURCHASER COLUMN**

Place an "X" in this column to indicate that the ownership or control of the products transported from the production unit has remained with the operator. (This means the entry is a combination operator-purchaser report.)

**PRODUCTION UNIT NUMBER COLUMN**

Each line entry on report must show the production unit number assigned by the Commission. Production unit suffixes are to be used by the remitter only.

**SCHEDULE 2 – PRODUCT SALES**

Each operator must complete this schedule to show the total volume and value of each kind of product sold from each production unit for the calendar month. The information reported by the operator in this schedule will be checked against the information reported by the purchaser and must agree by the production unit by production month. For reporting purposes, a sale takes place the date that the products are taken from a production unit.

COLUMN G – KIND – Use the letter "O" to designate liquid products; use the letter "G" to designate gas products.

COLUMN H – VOLUME – Report volume to the nearest whole barrel or MCF.

COLUMN J – VALUE – Value is the actual price received for products at the production unit before deductions. If there has been no sale of products, enter the word "none". Value subject to approval of any agency of the United States of America, State of New Mexico or any court must be shown separately from the approved value. Identify these entries with symbols or letters in the Volume Column and explain the identification on the last page of your report.

## ONLY REMITTERS WILL COMPLETE SCHEDULES 3 AND 4

**SCHEDULE 3 – DEDUCTIONS**

Deductions must be reported by individual production unit entry.

COLUMN K – TRUCKING EXPENSE – Show to the nearest whole dollar the reasonable expense of trucking the product from the production unit to the first place of market. (Trucking is the only transportation deduction allowable.)

COLUMN L – ROYALTY EXEMPTION – Show the royalty paid or due to the United States, State of New Mexico or any Indian tribe, Indian pueblo or Indian that is a ward of the United States of America.

**SCHEDULE 4 – TAXES AND ROYALTY REMITTED WITH THIS REPORT (METHOD OF COMPUTATION)**

The individual taxes and State Royalty must be computed and reported by individual production unit entry.

COLUMN N – SCHOOL TAX – From the value shown in column J, deduct any amounts shown in columns K and L, multiply the remainder by .0255.

COLUMN O – SEVERANCE TAX – From the value shown in column J, deduct any amounts shown in columns K and L, multiply the remainder by .0375.

COLUMN P – CONSERVATION TAX – From the value shown in column J, deduct any amounts shown in columns K and L, multiply the remainder by .0018

COLUMN R – AD VALOREM TAX – From the value shown in column J, deduct any amounts shown in columns K and L, divide the remainder by 2 and multiply this amount by the tax rate applicable to the production unit.

COLUMN S – STATE ROYALTY – From the value shown in column J, deduct any amount shown in column K; multiply the remainder by .125.

## AMENDED REPORTS

Applications for recovery of excess tax and royalty and corrections for erroneous reports are prepared in identical manner. Amended reports must be prepared, consisting of a separate unit report, form 0-2, and remittance report, form 0-1, for each reporting month. Only those production units being corrected are to be included, and each production unit must show these entries:

(1) Original entry. Use parenthesis to indicate a credit entry or the word "none" if there was no original entry.

(2) Corrected entry. This entry will show the corrections being made.

**THE TIME LIMITATION ALLOWED FOR RECOVERY OF EXCESS TAX IS ONE YEAR FROM FINAL DETERMINATION OF VALUE. THE TIME LIMITATION FOR RECOVERY OF ERRONEOUS TAX PAID IS ONE YEAR FROM DATE TAX WAS RECEIVED BY THE COMMISSION. NO EXTENSION OF TIME CAN BE ALLOWED.**

*NOTE:*

*Total each column at bottom of page. Show grand total of all pages on last page of report and transfer to applicable lines on form 0-1.*

EXHIBIT "I"

OPERATORS UNIT REPORT

0-2

OIL AND GAS ACCOUNTING COMMISSION
P. O. BOX 2308 SANTA FE, NEW MEXICO

REPORT MONTH February 19 78 PAGE 1

REPORTING COMPANY New Mexico Oil Company

| FOR REPORTERS USE | NO PURCHASER | PRODUCTION UNIT NUMBER | SCHEDULE 2 PRODUCT SALES G KIND | H VOLUME BBL-MCF | J VALUE | SCHEDULE 3 DEDUCTIONS K TRUCKING EXPENSE | L ROYALTY EXEMPTION | SCHEDULE 4 TAXES AND ROYALTY REMITTED WITH THIS REPORT N SCHOOL TAX | O SEVERANCE TAX | P CONSERVATION TAX | R AD VALOREM TAX | S STATE ROYALTY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5678 | O | 1900 | 10,167.25 | | | | | | | |
| | | | G | 728 | 378.50 | | | | | | | |
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| TOTAL THIS PAGE- | | | | | | | | | | | | |
| GRAND TOTAL LAST PAGE ONLY- | | | | | | | | | | | | |

USE DECIMALS TO DESIGNATE CENTS. DO NOT USE COMMAS TO DESIGNATE THOUSANDS.

# EXHIBIT "J"

## M - REPORTS

### RULE 1100. GENERAL

A. Where to File Reports

Unless otherwise specifically provided for in any rule or order of the Commission, all forms and reports required by these rules shall be filed with the appropriate District Office of the Commission as provided in Rules 1301 and 1302.

B. Additional Data

These rules shall not be construed to limit or restrict the authority of the Oil Conservation Commission to require the furnishing of such additional reports, data, or other information relative to the production, transportation, storing, refining, processing, or handling of crude petroleum oil, natural gas, or products in the State of New Mexico as may appear to it to be necessary or desirable, either generally or specifically, for the prevention of waste and the conservation of natural resources of the State of New Mexico.

C. Books and Records

All producers, transporters, storers, refiners, gasoline or extraction plant operators, and initial purchasers of natural gas within the State of New Mexico shall make and keep appropriate books and records for a period of not less than five years, covering their operations in New Mexico, from which they may be able to make and substantiate the reports required by these rules.

D. Written Notices, Requests, Permits, and Reports

The forms listed below shall be used for the purpose shown in accordance with the instructions printed thereon and the rule covering the form, or any special rule or order pertaining to its use.

| | |
|---|---|
| Form C-101 | Application for Permit to Drill, Deepen, or Plug Back |
| Form C-102 | Well Location and Acreage Dedication Plat |
| Form C-103 | Sundry Notices and Reports on Wells |
| Form C-104 | Request for Allowable and Authorization to Transport Oil and Natural Gas |
| Form C-105 | Well Completion or Recompletion Report and Log |
| Form C-106 | Notice of Intention to Utilize Automatic Custody Transfer Equipment |
| Form C-107 | Application for Multiple Completion |
| Form C-108 | Application to Dispose of Salt Water by Injection into a Porous Formation |
| Form C-109 | Application for Discovery Allowable and Creation of a New Pool |
| Form C-111 | Gas Purchaser's Monthly Report (Sheet 1 and Sheet 2) |
| Form C-112 | Transporter's and Storer's Monthly Report |
| Form C-113 | Refiner's Monthly Report (Sheet 1 and Sheet 2) |
| Form C-115 | Operator's Monthly Report |
| Form C-115-EDP | Operator's Monthly Report (electronic data processing) |
| Form C-116 | Gas-Oil Ratio Tests |
| Form C-117-A | Sediment Oil Destruction Permit |
| Form C-117-B | Sediment Oil Recovery Permit |
| Form C-118 | Treating Plant Operator's Monthly Report (Sheet 1 and Sheet 1-A) |
| Form C-119 | Carbon Black Plant Monthly Report |
| Form C-120 | Monthly Injection Report |
| Form C-120-A | Monthly Water Disposal Report |
| Form C-121 | Crude Oil Purchaser's Nomination |
| Form C-121-A | Purchaser's Gas Nomination |
| Form C-122 | Multi-Point and One Point Back Pressure Test for Gas Wells |
| Form C-122-A | Gas Well Test Data Sheet-San Juan Basin (Initial Deliverability Test, blue paper; Annual Deliverability Test, white) |
| Form C-122-B | Initial Potential Test Data Sheet |
| Form C-122-C | Deliverability Test Report |
| Form C-122-D | Worksheet for Calculation of Static Column Wellhead Pressure ($P_w$). |
| Form C-122-E | Worksheet for Stepwise Calculation of (Surface) (Subsurface) Pressure ($P_c$ & $P_w$) ($P_f$ & $P_s$) |
| Form C-122-F | Worksheet for Calculation of Wellhead Pressures ($P_c$ or $P_w$) from Known Bottomhole Pressure ($P_f$ or $P_s$) |
| Form C-122-G | Worksheet for Calculation of Static Column Pressure at Gas Liquid Interface |
| Form C-123 | Request for the Extension of an Existing Pool or the Creation of a New Pool |

| | |
|---|---|
| Form C-124 | Reservoir Pressure Report |
| Form C-125 | Gas Well Shut-in Pressure Report |
| Form C-126 | Permit to Transport Recovered Load Oil |
| Form C-127 | Request for Allowable Change |
| Form C-129 | Application for Exception to No-Flare Rule 306 |

RULE 1101. APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK (Form C-101)

Before commencing drilling or deepening operations, or before plugging a well back to another zone, the operator of the well must obtain a permit to do so. To obtain such permit, the operator shall submit to the Commission FIVE copies of Form C-101, Application for Permit to Drill, Deepen, or Plug Back, completely filled out. If the operator has an approved bond in accordance with Rule 101, one copy of the Drilling Permit will be returned to him on which will be noted the Commission's approval, with any modification deemed advisable. If the proposal cannot be approved for any reason, the Forms C-101 will be returned with the cause for rejection stated thereon.

Form C-101 must be accompanied by THREE copies of Form C-102, Well Location and Acreage Dedication Plat. (See Rule 1102.)

If the well is to be drilled on state land, submit SIX copies of Form C-101 and FOUR copies of Form C-102, the extra copy of each form being for the State Land Office.

RULE 1102. WELL LOCATION AND ACREAGE DEDICATION PLAT (Form C-102)

Form C-102 is a dual purpose form used to show the exact location of the well and the acreage dedicated thereto. The form is also used to show the ownership and status of each lease contained within the dedicated acreage. When there is more than one working interest or royalty owner on a given lease, designation of the majority owner et al. will be sufficient.

All information required on Form C-102 shall be filled out and certified by the operator of the well except the well location on the plat. This is to be plotted from the outer boundaries of the section and certified by a registered professional engineer and/or land surveyor, registered in the State of New Mexico, or a surveyor approved by the Commission.

Form C-102 shall be submitted in TRIPLICATE or QUADRUPLICATE as provided in Rule 1101.

Amended Form C-102 (in TRIPLICATE or QUADRUPLICATE) shall be filed in the event there is a change in any of the information previously submitted. The well location need not be certified when filing amended Form C-102.

RULE 1103. SUNDRY NOTICES AND REPORTS ON WELLS (Form C-103)

Form C-103 is a dual purpose form to be filed with the appropriate District Office of the Commission to obtain Commission approval prior to commencing certain operations and also to report various completed operations.

A. Form C-103 as a Notice of Intention

Form C-103 shall be filed in TRIPLICATE by the operator and approval obtained from the Commission prior to:

(1) Effecting a change of plans from those previously approved on Form C-101 or Form C-103.

(2) Altering a drilling well's casing program or pulling casing or otherwise altering an existing well's casing installation.

(3) Temporarily abandoning a well.

(4) Plugging and abandoning a well.

(5) Performing remedial work on a well which, when completed, will affect the original status of the well. (This shall include making new perforations in existing wells or squeezing old perforations in existing wells, but is not applicable to new wells in the process of being completed nor to old wells being deepened or plugged back to another zone when such recompletion has been authorized by an approved Form C-101, Application for Permit to Drill, Deepen, or Plug Back, nor to acidizing, fracturing, or cleaning out previously completed wells, nor to installing artificial lift equipment.)

In the case of well plugging operations, the Notice of Intention shall include a detailed statement of the proposed work, including plans for shooting and pulling casing, plans for mudding, including weight of mud, plans for cementing, including number of sacks of cement and depths of plugs, and the time and date of the proposed plugging operations. If not previously filed, a complete log of the well on Form C-105 (See Rule 1105) shall accompany the Notice of Intention to plug the well; the bond will not be released until this is complied with.

B. Form C-103 as a Subsequent Report

Form C-103 as a subsequent report of operations shall be filed in accordance with the section of this rule applicable to the particular operation being reported.

Form C-103 is to be used in reporting such completed operations as:

(1) Commencement of drilling operations
(2) Casing and cement test
(3) Altering a well's casing installation
(4) Temporary abandonment
(5) Plug and Abandon
(6) Plugging back or deepening
(7) Remedial work
(8) Installation of artificial lifting equipment
(9) Change in ownership of a drilling well
(10) Such other operations which affect the original status of the well but which are not specifically covered herein

Information to be entered on Form C-103, Subsequent Report, for a particular operation is as follows:

(1) Report of Commencement of Drilling Operations

Within ten days following the commencement of drilling operations, the operator of the well shall file a report thereof on Form C-103 in TRIPLICATE. Such report shall indicate the hour and the date the well was spudded.

(2) Report of Results of Test of Casing and Cement Job; Report of Casing Alteration

A report of casing and cement test shall be filed by the operator of the well within ten days following the setting of each string of casing or liner. Said report shall be filed in TRIPLICATE on Form C-103 and shall present a detailed description of the test method employed and the results obtained by such test, and any other pertinent information required by Rule 107. The report shall also indicate the top of the cement and the means by which such top was determined. It shall also indicate any changes from the casing program previously authorized for the well.

(3) Report of Temporary Abandonment

A report of temporary abandonment of a well shall be filed by the operator of the well within ten days following completion of the work. The report shall be filed in TRIPLICATE and shall present a detailed account of the work done on the well, including location and type of plugs used, if any, type and status of surface and downhole equipment, and any other pertinent information relative to the overall status of the well.

(4) Report on Plugging of Well

A report of plugging operations shall be filed by the operator of the well within 30 days following completion of plugging operations on any well. Said report shall be filed in TRIPLICATE on Form C-103 and shall include the date the plugging operations were begun and the date the work was completed, a detailed account of the manner in which the work was performed including the depths and lengths of the various plugs set, the nature and quantities of materials employed in the plugging operations including the weight of the mud used, the size and depth of all casing left in the hole, and any other pertinent information. (See Rules 201-204 regarding plugging operations.)

No plugging report will be approved by the Commission until the pits have been filled and the location levelled and cleared of junk. It shall be the responsibility of the operator to contact the appropriate District Office of the Commission when the location has been so restored in order to arrange for an inspection of the plugged well and the location by a Commission representative.

(5) Report of Remedial Work

A report of remedial work performed on a well shall be filed by the operator of the well within 30 days following completion of such work. Said report shall be filed in QUADRUPLICATE on Form C-103 and shall present a detailed account of the work done and the manner in which such work was performed; the daily production of oil, gas, and water both prior to and after the remedial operation; the size and depth of shots; the quantity of sand, crude, chemical or other materials employed in the operation, and any other pertinent information. Among the remedial work to be reported on Form C-103 are the following:

(a) Report on shooting, fluid fracturing or chemical treatment of a previously completed well
(b) Report on squeeze job
(c) Report on setting of liner or packer
(d) Report of installation of pumping equipment or gas lift facilities
(e) Report of any other remedial operations which are not specifically covered herein

(6) Report on Deepening or Plugging Back

A report of deepening or plugging back shall be filed by the operator of the well within 30 days following completion of such operations on any well. Said report shall be filed in QUADRUPLICATE on Form C-103 and shall present a detailed account of the work done and the manner in which such work was performed. If the well is recompleted in the same pool, it shall also report the daily production of oil, gas, and water both prior to and after recompletion. If the well is recompleted in another pool, Form C-104 must also be filed in accordance with Rule 1104.

(7) Report of Change in Ownership of a Drilling Well

A report of change of ownership shall be filed by the new owner of any drilling well within ten days following actual transfer of ownership. Said report shall be filed in TRIPLICATE on Form C-103 and shall include the name and address of both the new owner and the previous owner, the effective date of the change of ownership, and any other pertinent information. No change in the ownership of a drilling well will be approved by the Commission unless the new owner has an approved bond in accordance with Rule 101. (Form C-104 shall be used to report transfer of ownership of a completed well; see Rule 1104.)

(8) Other Reports on Wells

Reports on any other operations which affect the original status of the well but which are not specifically covered herein shall be submitted to the Commission on Form C-103, in TRIPLICATE, by the operator of the well within ten days following the completion of such operation.

RULE 1104. REQUEST FOR ALLOWABLE AND AUTHORIZATION TO TRANSPORT OIL AND NATURAL GAS (Form C-104)

(1) Form C-104 completely filled out by the operator of the well must be filed in QUINTUPLICATE before an allowable will be assigned to any newly completed or recompleted well. (A recompleted well shall be considered one which has been deepened or plugged back to produce from a different pool than previously.) Form C-104 must be accompanied by a tabulation of all deviation tests taken on the well as provided by Rule 111.

(2) The allowable assigned to an oil well shall be effective at 7:00 o'clock a.m. on the date of completion, provided the Form C-104 is received by the Commission during the month of completion. Date of completion shall be that date when new oil is delivered into the stock tanks.

Unless otherwise specified by special pool rules, the allowable assigned to a gas well shall be effective at 7:00 o'clock a.m. on the date of connection to a gas transportation facility, as evidenced by an affidavit of connection from the purchaser to the Commission, or the date of receipt of Form C-104 by the Commission, whichever date is later.

(3) No allowable will be assigned to any well until a standard unit for the pool in which the well is completed has been dedicated by the owner, or a non-standard unit has been approved by the Commission, or a standard unit has been communitized or pooled and dedicated to the well.

(4) No allowable will be assigned to any well until all forms and reports due have been received by the Commission and the well is otherwise in full compliance with these rules.

(5) Form C-104 with Sections I, II, III, and VI, completely filled out shall be filed in QUINTUPLICATE by the operator of the well in the event there is a change of ownership of any producing well, injection well, or disposal well, or a change of transporter (oil, condensate, casinghead gas, or dry gas), a change in pool designation, lease name, or well number, or any other pertinent change in condition of any such well. When filing Form C-104 for change of ownership, the new operator shall file the form in the above manner, and shall give the name and address of the previous as well as the present operator. The Form C-104 will not be approved by the Commission unless the new operator has an approved bond in compliance with Rule 101.

(6) Whenever there is a temporary change in transporter and oil is to be moved from the lease by anyone other than the regular transporter authorized by an approved Form C-104, the operator shall notify the appropriate District Office of the Commission in writing within three days after the oil is moved, furnishing such information as may be required by the District Office. The operator shall furnish copies of the notification to the regular transporter and to the temporary transporter. This paragraph is intended to deal primarily with authorized batch movements of oil by the operator for use as load oil, frac oil, etc.; eventual sale of this oil is governed by Rules 508 and 1126.

RULE 1105. WELL COMPLETION OR RECOMPLETION REPORT AND LOG (Form C-105)

Within 20 days following the completion or recompletion of any well, the operator shall file Form C-105 with the Commission. It must be filed in QUINTUPLICATE and each copy accompanied by a summary of all special tests conducted on the well, including drill stem tests. In addition, one copy of all electrical and radio-activity logs run on the well must be filed with Form C-105. If the Form C-105 with attached log(s) and summaries is not received by the Commission within the specified 20-day period, the allowable for the well will be withheld until this rule has been complied with.

In the case of a dry hole, a complete record of the well on Form C-105 with the above attachments shall accompany the notice of intention to plug the well, unless previously filed. The plugging report will not be approved nor the bond released until this rule has been complied with.

Form C-105 and accompanying attachments will not be kept confidential by the Commission unless so requested in writing by the owner of the well. Upon such request, the Commission will keep these data confidential for 90 days from the date of completion of the well, provided, however, that the report, log(s), and other attached data may, when pertinent, be introduced in any public hearing before the Commission or its examiners or in any court of law, regardless of the request that they be kept confidential.

RULE 1106. NOTICE OF INTENTION TO UTILIZE AUTOMATIC CUSTODY TRANSFER EQUIPMENT (Form C-106)

Form C-106, when applicable, shall be filed in accordance with Rule 309-A.

RULE 1107. APPLICATION FOR MULTIPLE COMPLETION (Form C-107)

Form C-107, when applicable, shall be filed in accordance with Rule 112-A IV.

RULE 1108. APPLICATION TO DISPOSE OF SALT WATER BY INJECTION INTO A POROUS FORMATION (Form C-108)

Form C-108, when applicable, shall be filed in accordance with Rule 701, Section C.

RULE 1109. APPLICATION FOR DISCOVERY ALLOWABLE AND CREATION OF A NEW POOL (Form C-109)

Form C-109, when applicable, shall be filed in accordance with Rule 509.

RULE 1110. No Rule; there is no Form C-110 at present.

RULE 1111. GAS PURCHASER'S MONTHLY REPORT (Form C-111)

Form C-111, Gas Purchaser's Monthly Report, shall be filed monthly in accordance with the rules below. It shall be postmarked on or before the 15th day of the month to report all gas taken during the preceding month. One copy shall be filed with the appropriate District Office of the Commission and two copies with the Santa Fe Office of the Commission. One additional copy shall also be sent to the Hobbs Office of the Commission. Information on Sheet No. 2 of Form C-111 shall be itemized by pools, by operators, and by leases, in alphabetical order.

Form C-111 shall be filed each month by the operator of any gas gathering system, gas transportation system, recycling system, fuel system, gas lift system, gas drilling operation, etc. The form shall cover all natural gas, casinghead gas, and carbon dioxide gas taken into any such system during the preceding month and shall show the source of the gas and the disposition thereof.

Form C-111 shall also be filed each month by the operator of any gasoline plant, cycling plant, or other plant at which gasoline, butane, propane, kerosene, oil, or other products are extracted from gas within the State of New Mexico. The form shall cover all natural gas, casinghead gas, and carbon dioxide gas taken by any such plant during the preceding month and shall show the source of the gas and the disposition thereof. If a plant operator owns more than one plant in a given OCC District, Sheet No. 1 of Form C-111 shall be filed for each such plant. In preparing Sheet No. 2, the plant operator shall consolidate all acquisitions for all plants in the District, itemized in the order described in the first paragraph of this rule.

Where gas is taken by the producer and utilized by him for any of the above uses, the producer shall file Form C-111 itemizing such gas. The producer shall also include this gas on his Operator's Monthly Report, Form C-115. Gas used on the lease from which it was produced for consumption in lease houses, treaters, compressors, combustion engines, and other similar equipment, or gas which is flared, shall also be included on the Form C-115 but is not to be included on the Form C-111.

RULE 1112. TRANSPORTER'S AND STORER'S MONTHLY REPORT (Form C-112)

Each transporter and each storer of crude petroleum oil and liquid hydrocarbons within the State of New Mexico shall file for each calendar month a Transporter's and Storer's Monthly Report, Form C-112, containing complete information and data indicated by such form respecting stocks of crude petroleum oil and liquid hydrocarbons on hand and receipts and deliveries of crude petroleum oil and liquid hydrocarbons by pipeline and trucks within the State of New Mexico, and receipts and deliveries from leases to storers or refiners; between transporters within the State; between storers and refiners within the State. Form C-112 shall be filed in DUPLICATE and postmarked on or before the 15th day of the next succeeding month.

RULE 1113. REFINER'S MONTHLY REPORT (Form C-113)

Every refiner of crude petroleum oil within the State of New Mexico shall furnish for each calendar month a Refiner's Monthly Report, Form C-113, containing the information and data indicated by such form respecting crude petroleum oil and products involved in such refiner's operation during each month. Such report for each month shall be filed in DUPLICATE and be postmarked on or before the 15th day of the next succeeding month.

RULE 1114. No Rule; there is no Form C-114 at present.

RULE 1115. OPERATOR'S MONTHLY REPORT (Form C-115)

Operator's Monthly Report, Form C-115 or Form C-115-EDP, shall be filed on each producing lease within the State of New Mexico for each calendar month, setting forth complete information and data indicated on said forms. Oil production from wells which are producing into common storage shall be estimated as accurately as possible on the basis of periodic tests.

The reports on this form shall be filed by the producer as follows:

> Original to the Oil Conservation Commission at Santa Fe; one copy to the Oil Conservation Commission District Office at Hobbs; one copy to the District Office in which district the lease is located; and one copy to each transporter involved. Each report for each month shall be postmarked not later than the 24th day of next succeeding month. Failure of an operator to file this report in accordance with the provisions of this rule may result in cancellation of Form C-104 for the affected well or wells.

RULE 1116. GAS-OIL RATIO TESTS (Form C-116)

Gas-oil ratio tests shall be made and reported on Form C-116 as prescribed in Rule 301, Gas-Oil Ratio Tests, and any applicable special pool rules. This form shall be submitted in DUPLICATE.

RULE 1117. SEDIMENT OIL DISPOSITION PERMITS (Form C-117-A and Form C-117-B)

(a) Form C-117-A, Sediment Oil Destruction Permit, shall be submitted to the appropriate District Office of the Commission in TRIPLICATE and in accordance with Rule 311 (b).

(b) Form C-117-B, Sediment Oil Recovery Permit, shall be submitted to the appropriate District Office of the Commission in QUADRUPLICATE and in accordance with Rule 311 (c).

RULE 1118. TREATING PLANT OPERATOR'S MONTHLY REPORT (Form C-118)

Form C-118 shall be submitted in DUPLICATE in accordance with Rule 312, and shall contain all the information required thereon. Column 1 of Sheet 1-A of Form C-118 entitled "Permit Number," has reference to the Sediment Oil Recovery Permit, Form C-117-B, for each lot of oil picked up for processing.

RULE 1119. CARBON BLACK PLANT MONTHLY REPORT (Form C-119)

Each operator of a carbon black plant within the State of New Mexico shall file for each calendar month the monthly volume of gas received by him from a gasoline extraction plant or plants, and a monthly volume or volumes of gas received by him from each lease operator delivering natural gas directly to such plant, together with the opening and closing stocks and the production and deliveries by grades of carbon black or other products produced. Such reports shall be filed in DUPLICATE on Form C-119, Carbon Black Plant Monthly Report, and be postmarked on or before the 15th day of the next succeeding month. In addition, Form C-111 shall be filed each month in accordance with Rule 1111 if the Carbon Black Plant operator makes any purchase directly from a lease or operates any gas gathering or transmission system.

RULE 1120. MONTHLY INJECTION REPORT (Form C-120) and MONTHLY WATER DISPOSAL REPORT (Form C-120-A)

Form C-120 and Form C-120-A shall be submitted in TRIPLICATE each month and shall be used for reports required under Rule 704. Form C-120 shall be postmarked not later than the 15th day of the next succeeding month. Form C-120-A shall be postmarked not later than the 15th day of the second succeeding month.

RULE 1121. PURCHASER'S NOMINATION FORMS (Form C-121 and Form C-121-A)

Unless requested otherwise by the Secretary-Director of the Commission, one copy of Form C-121, Crude Oil Purchaser's Nomination, shall be submitted to the Santa Fe office of the Commission not later than the 20th day of each odd-numbered month. Nominations shall be filed by each person expecting to purchase oil from producing wells in New Mexico during the second and third succeeding two months. As an example, nominations submitted by the 20th day of July shall indicate the amount of oil the purchaser desires to purchase daily during September and October.

One copy of Form C-121-A, Purchaser's Gas Nomination, shall be submitted to the Santa Fe office of the Commission by the first day of the month during which the Commission will consider at the gas allowable hearing the nominations for the purchase of gas from producing wells in New Mexico during the succeeding month. As an example, purchaser's nominations to take gas from a pool during the month of August would be considered by the Commission at a hearing during July, and should be submitted to the Santa Fe office of the Commission by July 1.

In addition to the monthly gas nominations, twelve-months nominations shall be filed in accordance with the appropriate pool rules.

RULE 1122. MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL (Form C-122)

GAS WELL TEST DATA SHEET - SAN JUAN BASIN (Form C-122-A)

INITIAL POTENTIAL TEST DATA SHEET (Form C-122-B)

DELIVERABILITY TEST REPORT (Form C-122-C)

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE ($P_w$) (Form C-122-D)

WORKSHEET FOR STEPWISE CALCULATION OF (SURFACE) (SUBSURFACE) PRESSURE ($P_c$ & $P_w$) ($P_f$ & $P_s$) (Form C-122-E)

WORKSHEET FOR CALCULATION OF WELLHEAD PRESSURES ($P_c$ or $P_w$) FROM KNOWN BOTTOMHOLE PRESSURE ($P_f$ or $P_s$) (Form C-122-F)

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE (Form C-122-G)

The above forms shall be submitted to the appropriate district office of the Commission in accordance with the provisions of the "Manual for Back-Pressure Testing of Natural Gas Wells," Rule 401 of the Commission Rules and Regulations, and applicable special pool rules and proration orders. These forms shall be submitted in DUPLICATE except Form C-122-A which shall be submitted in TRIPLICATE.

RULE 1123. REQUEST FOR THE EXTENSION OF AN EXISTING POOL OR THE CREATION OF A NEW POOL (Form C-123)

The operator of a well which requires the creation or extension of a pool shall be given written instructions by the appropriate district office regarding the filing of Form C-123 in DUPLICATE.

RULE 1124. RESERVOIR PRESSURE REPORT (Form C-124)

Form C-124 shall be submitted in TRIPLICATE and shall be used to report bottom-hole pressures as required under the provisions of Rule 302 and any applicable special pool rules.

RULE 1125. GAS WELL SHUT-IN PRESSURE TESTS (Form C-125)

Form C-125 shall be submitted in TRIPLICATE and shall be used to report shut-in pressure tests on gas wells as required under the provisions of Rule 402 and any applicable special pool rules.

RULE 1126. PERMIT TO TRANSPORT RECOVERED LOAD OIL (Form C-126)

Form C-126 shall be submitted in QUADRUPLICATE to the appropriate District Office of the Commission and shall be used in conformance with Rule 508 and Rule 1104 (6).

RULE 1127. REQUEST FOR ALLOWABLE CHANGE (Form C-127)

One copy of Form C-127 shall be filed by the oil producer with the appropriate District Office of the Commission not later than the 10th day of the month preceding the month for which oil well allowable changes are requested.

RULE 1128. FORMS REQUIRED ON FEDERAL LAND

Federal forms shall be used in lieu of State forms when filing APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK and SUNDRY NOTICES AND REPORTS ON WELLS and WELL COMPLETION OR RECOMPLETION REPORT AND LOG for wells on Federal lands in New Mexico. However, it shall be the duty of the operator to submit two extra copies of each of such forms to the USGS, which, upon approval, will transmit same to the Commission. The following USGS forms will be used in lieu of Commission forms by operators of wells on Federal land:

| USGS Form No. | Title of Form (Same for both agencies) | NMOCC Form No. |
|---|---|---|
| 9-331C (May 1963) | APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK | C-101 |
| 9-331 (May 1963) | SUNDRY NOTICES AND REPORTS ON WELLS | C-103 |
| 9-330 (Rev. 5-63) | WELL COMPLETION OR RECOMPLETION REPORT AND LOG | C-105 |

The above forms as may be revised are the only forms that may be submitted in place of Commission forms.

After a well is completed and ready for pipeline connection, Commission Form C-104 shall be filed with the Commission on any and all wells drilled in the State, regardless of land status. Further, all reports and forms as required under the preceding rules of this section of the Rules and Regulations that pertain to production must be filed on the proper Oil Conservation Commission form as set out in said rule - no other forms will be accepted.

Failure to comply with the provisions of this rule will result in the cancellation of Form C-104 for the affected well or wells.

RULE 1129. APPLICATION FOR EXCEPTION TO NO-FLARE RULE 306 (Form C-129)

Form C-129, when applicable, shall be filed in accordance with Rule 306.

PRODUCTION SECRETARY

Vocabulary

Abandon v: to cease producing oil or gas from a well. When a well is no longer capable of producing profitably, it is abandoned. A wildcat well may be abandoned after it has been determined that it will not produce. Several steps are involved in abandoning a well: the casing is removed and salvaged; one or more cement plugs are placed in the borehole to prevent migration of fluids between the different formations penetrated by the borehole; and the well is plugged and abandoned. In many countries, it is necessary to secure permission from official agencies before a well may be abandoned.

Abdn abbr: the abbreviation for abandoned; used in drilling reports.

Abnormal pressure n: the pressure exerted by a formation that exceeds or falls below the normal pressure to be expected at a given depth. Normal pressure increases approximately 0.465 psi per foot of depth. Thus, at 10,000 ft normal pressure is 4,650 psi. If at 10,000 ft the pressure exceeds 4,650 psi, the pressure is abnormally high. If at 10,000 ft the pressure is less than 4,650 psi, the pressure is abnormally low. Formations with abnormally high pressure must be adequately controlled if a blowout is to be avoided. (See pressure gradient.)

Absolute permeability n: the permeability of rock to a single fluid if the rock is 100 percent saturated with that fluid.

Absolute porosity n: the percentage of the total bulk volume of a rock sample that is composed of pore spaces or voids. (See porosity.)

Absolute pressure n: the pressure reckoned from absolute zero pressure; or, commonly, gauge pressure plus the pressure of the atmosphere. Absolute pressure is expressed in units of force per unit of area, as pounds per square inch absolute (psia).

Absorb v: to recover liquid hydrocarbons from natural or refinery gas in a gas-absorption plant. The wet gas enters the absorber at the bottom and rises to the top, encountering a stream of absorption oil--a light oil or similar fraction--traveling downward over bubble-cap trays. The lighter-fraction removes (absorbs) the heavier liquid hydrocarbons from the wet gas.

Accumulate v: to amass or collect. When oil and gas migrate into more porous formations and collect in quantity, the quantity is said to be an accumulation.

Accumulator n: a vessel or tank that receives and temporarily stores a liquid used in a continuous process in a gas plant. On a drilling rig, the accumulator stores hydraulic fluid under pressure from compressed nitrogen or air for closing the blowout preventers. (See blowout-preventer control unit.) A drip accumulator collects the liquid hydrocarbons that condense out of a wet gas traveling through a pipeline. In some countries, a storage battery is referred to as an accumulator.

Acid n: any chemical compound, one element of which is hydrogen, that dissociates in solution to produce free-hydrogen ions. (See ion.) For example, hydrochloric acid, HCl, dissociates in water to produce hydrogen ions, $H^+$, and chloride ions, $Cl^-$. This is written chemically as $HCl \rightleftharpoons H^+ + Cl^-$. (See dissociation.)

Acidity n: the relative acid strengths of liquids as measured by pH; a pH value below 7. (See pH value.)

Acidize v: to treat oil-bearing limestone or other formations by chemical reaction with acid in order to increase production. Hydrochloric or other acid is injected into the formation under pressure. The acid etches the rock, bringing about an enlargement of the pore spaces and passages through which the reservoir fluids flow. The acid is held under pressure for a period of time and then pumped out. Finally, the well is swabbed and put back into production. Chemical inhibitors are combined with the acid to prevent corrosion of the pipe; other additives serve various purposes.

Acoustic survey n: a method that measures the time required for sound impulses to travel through a given length of rock. From the data, the porosity of the rock and the type of fluid contained in the void spaces of the rock

can be determined. This usually permits a reasonably accurate measurement of the effective porosity of given formation. This process is also called sonic logging.

Acre-foot n: a unit of volume often used in oil-reservoir analysis that is equivalent to the volume (as of oil or water) necessary to cover 1 acre to a depth of 1 ft.

Acre-ft abbr: the abbreviation for acre-foot.

Across prep: over. Usually, the term describes conditions of flow on one side of a piece of equipment as compared with conditions on the other side where a fluid is flowing (i.e., a pressure drop across a separator).

Additive n: a substance or compound that is added to a larger volume of another substance to change the characteristics of the latter. In the oil industry, additives are used in lubricating oil, fuel, drilling mud, and cement for cementing casing.

Adhere v: to stick or bond to (as paint to a metallic surface).

Adjustable choke n: a choke in which a conical needle and seat is changed to vary the rate of flow through the choke.

Adsorption n: the adhesion of a thin film of a gas or liquid to the surface of a solid. Liquid hydrocarbons are recovered from natural gas by passing the gas through activated charcoal, which extracts the heavier hydrocarbons. Steam treatment of the charcoal removes the adsorbed hydrocarbons, which are collected and recondensed.

Air-balanced beam-pumping unit n: (See sucker-rod pumping.)

Alkali n: (See base.)

Alkalinity n: the combining power of a base, or alkali, as measured by the number of equivalents of an acid with which it reacts to form a salt.

Allocation n: a distribution of the production from a number of wells in a particular field. When the total production from the field is known, then each well is adjusted to produce at the most efficient rate.

Allowable n: the amount of oil or gas that may be produced from a well per unit of time. In states using

proration, this figure is established monthly by the conservation agency of the state.

Annulus n: (See annular space.)

Anticlinal trap n: a hydrocarbon trap where petroleum accumulates in the top of an anticline.

Antifreeze n: a chemical compound that prevents the water in the cooling system of an engine from freezing; ethylene glycol.

Antiknock compound n: any substance, but usually tetraethyl lead, that is added to the fuel of an internal-combustion engine to prevent detonation of the fuel. Antiknock compounds effectively raise the octane rating of a fuel so that the fuel burns properly in the combustion chamber of the engine.

API abbr: the abbreviation for the American Petroleum Institute. Founded in 1920, this national oil trade association maintains a Division of Production with offices in Dallas, Texas. The API is the leading standardizing organization on oil-field drilling and producing equipment, having published a great many codes covering such matters. Also, it has divisions of transportation, refining, and marketing. National headquarters are in Washington, D.C. Also, in the oil field, API is used as an expression to indicate that a job is being done properly (as, "Strictly API"). However, the term is used sarcastically to indicate that someone or something is not working right, as usual (as, "It's API for that engine (to be broken down)").

API abbr: the abbreviation for degrees API; used to designate API gravity.

API gravity n: the measure of the gravity of liquid petroleum products on the North American continent derived from specific gravity in accordance with the following equation:

$$\text{API gravity} = \frac{141.5}{\text{specific gravity}} - 131.5$$

API gravity is expressed in degrees, a specific gravity of 1.0 being equivalent to $10^{\circ}$ API.

Artificial lift n: any method to raise oil to the surface through a well after reservoir pressure has declined to the point at which the well no long produces by

natural energy. Sucker-rod pumps, hydraulic pumps, submersible pumps, and gas lift are the most common methods of artificial lift.

Asphalt-base oil n: (See naphthene-base oil.)

Asphaltic material n: one of a group of solid, liquid, or semisolid materials that are predominantly mixtures of hydrocarbons and their nonmetallic derivatives and are obtained either from natural bituminous deposits or from the residues of petroleum refining.

Atmospheric pressure n: the pressure exerted over the surface of the earth by the weight of the atmosphere. At sea level, this pressure is approximately 14.7 psi.

Automatic control n: a device installed in such a way that it regulates various factors (as the flow rate, pressure, or temperature of a system) without a person being in attendance at all times. (See instrumentation.)

Automatic gauge n: an instrument installed at eye level on the outside of a tank for observing the depth of a liquid inside the tank.

Automatic pumping station n: an automatically operated station installed in a pipeline to increase the line pressure when transporting a fluid.

Automatic shutdown n: a system in which certain instruments are used to control the operating conditions of a process. If conditions are not normal, the instruments automatically stop the process and send a signal to the operator.

Auxilliary equipment n: that equipment subsidiary or supplementary to the main equipment used in an operation.

Back-in unit n: a portable servicing or workover rig that is self-propelled, using the hoisting engines for motive power. The driver's cab is mounted on the end opposite the mast support; thus, the unit must be backed up to the wellhead. (See carrier rig.)

Back-off v: unscrew one threaded piece (as a section of pipe) from another.

Back-off joint n: a section of pipe with left-hand threads on one end and conventional right-hand threads on the other. In setting a liner, a back-off joint is attached to it so that the drill pipe may be disengaged from the liner by conventional right-hand rotation.

Back up v: to hold one section of an object (as pipe) while another is being screwed into or out of it. A backup wrench refers to any wrench being used to hold a pipe or bolt to prevent it from turning while another length of pipe or a nut is being applied or loosened.

Baffle plate n: a partial restriction, generally a plate, located to change the direction, guide the flow, or promote mixing within a tank or vessel in which it is installed.

Bail v: to recover bottom-hole fluids, samples, or drill cuttings by lowering a cylindrical vessel, called a bailer, to the bottom of a well and retrieving it.

Bailer n: a long cylindrical container, fitted with a valve at its lower end, used to remove water, sand, mud, and oil from a well.

Barrel (bbl) n: a unit of measure of volume for petroleum products. One barrel (1 bbl) is the equivalent of 42 U.S. gal, or approximately 35 imperial gal, or approximately 158.97 liters. One $m^3$ equals 6.2897 bbl.

Barrels per day (BPD, bpd, B/D, b/d) n: a measure of the rate of flow of a well; the total amount of oil produced or processed per day. It is frequently abbreviated as BPD or bpd and sometimes as b/d or B/D.

Base n: substance that is capable of combining with charged hydrogen atoms (ions) to form a salt. A typical base is sodium hydroxide (caustic), with a chemical symbol of NaOH. As an example, sodium hydroxide combines with hydrochloric acid to form sodium chloride (a salt) and water; this reaction is written chemically as

$$NaOH + HCl \quad NaCl + H_2O.$$

Basic sediment and water (BS&W) n: the water and other extraneous material present in crude oil. Usually, the BS&W content must be quite low before a pipeline will accept the oil for delivery to a refinery. The amount acceptable depends on a number of factors but may run from less than 5 percent to small fractions of a percent.

Basin n: a synclinal structure in the subsurface, formerly the bed of an ancient sea. Because basins are composed of sedimentary rock and because basin contours provide traps for petroleum, basins are regarded as good prospects for exploration. The Permian Basin in West Texas is an example of a major oil-producing basin.

Battery n: an installation of identical or nearly identical pieces of equipment (as a tank battery or a battery of meters); an electricity storage device.

bbl abbr: the abbreviation for barrel.

bbl/d abbr: the abbreviation for barrels per day.

Bcf abbr: the abbreviation for billion cubic geet of gas.

Bcf/d abbr: the abbreviation for billion cubic feet of gas per day.

b/d abbr: the abbreviation for barrels per day; used in drilling reports.

B/D abbr: the abbreviation for barrels per day.

BDC abbr: the abbreviation for bottom dead center.

Beam n: the extreme width of the hull of a ship or mobile, offshore drilling rig.

Beam counterbalance n: the weights installed on the end of the walking beam, which is opposite from the end over the well. The counterbalance offsets, or balances, the weight of the sucker rods and other downhole equipment installed in the well. (See sucker-rod pumping.)

Beam-pumping unit n: a machine designed specifically for sucker-rod pumping, utilizing a horizontal member (walking beam) that is worked up and down in a seesaw motion by a rotating crank to produce reciprocating motion.

BHP abbr: the abbreviation for bottom-hole pressure.

Bleed v: to drain off liquid or gas, generally slowly, through a valve called a bleeder. To bleed down, or bleed off, means to slowly release the pressure of a well or of pressurized equipment.

BLPD abbr: the abbreviation for barrels of liquid per day. This abbreviation usually refers to total oil and water produced from a well in terms of barrels per day.

BO n: the abbreviation for barrels of oil; used in drilling reports.

Boiler house v: to make up or fake a report without actually doing the work (slang).

Booster station n: an installation near a pipline whose function is to receive oil through a mian pipeline and transmit it to the next station. It receives no oil from any other sources, nor does it have a tank farm.

BOPD n: the abbreviation for barrels of oil per day.

Bottle test n: a test in which samples of emulsion are placed in a number of bottles in order to determine how much of what chemical is required to break the emulsion into oil and water.

Bottom dead center (BDC) n: a term that refers to the piston at the lowest point possible in the cylinder of an engine. Often, this position is marked on the engine fly-wheel.

Bottom-hole adj: descriptive of the lowest or deepest part of a well.

Bottom-hole choke n: a device with a restricted opening that is placed in the lower end of the tubing through which the oil flows to the surface. Its purpose is to control the rate of flow. (See choke.)

Bottom-hole packer n: a device that prevents communication through the annular space between two strings of pipe and is installed near the bottom of the hole. (See packer.)

Bottom-hole plug n: a bridge plug or cement plug placed near the bottom of the hole to shut off a depleted, water-producing, or unproductive zone.

Bottom-hole pressure n: the pressure in a well at a point opposite the producing formation (as recorded by a bottom-hole-pressure bomb, a steel container that houses a precision gauge lowered on a wire line).

Bottom-hole pump n: any of the rod pumps, high-pressure liquid pumps, or centrifugal pumps located at or near the bottom of the well and used to lift the well fluids. (See sucker-rod pumping, hydraulic pumping, and submersible pump.)

Bottom-hole separator n: a device used to separate oil and gas at the bottom of pumping wells in order to increase the volumetric efficiency of the pumping equipment.

Bottoms n: the liquids and residue that collect in the bottom of a vessel (as the tank bottoms) and remain in the bottom of a storage tank after a period of service. The residual fractions remaining at the bottom of a fractionating tower after lighter components have been distilled off as vapors are also called bottoms or bottom product.

Bottom water n: water occurring below the oil and gas in a producing formation.

BPD abbr: the abbreviation for barrels per day.

bpd abbr: the abbreviation for barrels per day.

BPH abbr: the abbreviation for barrels per hour; used in drilling reports.

Bradenhead n: a connection at the top of oilwell casing onto which the wellhead equipment is fitted; now obsolete, casinghead being the preferred expression.

Bradenhead flange n: a flanged connection at the top of the oil-well casing.

Breakdown n: a failure in a piece of equipment.

Breakdown adj: descriptive of the amount of pressure at the wellhead needed to rupture the formation when performing a fracture treatment or squeeze job (as formation-breakdown pressure).

Break down v: to unscrew the drill stem into single joints and place them on the pipe rack. The operation takes place upon completion of the well, prior to running casing, when the drill pipe will no longer be used, or when changing from one size of pipe to another. This also is called laying down.

Bridge plug n: a downhole tool (composed primarily of slips, a plug mandrel, and a rubber sealing element) that is run and set in casing to isolate a lower zone while testing an upper section.

Brine n: water that has a large quantity of salt, especially sodium chloride, dissolved in it; salt water.

BW abbr: the abbreviation for barrels of water; used in drilling reports.

BWPD abbr: the abbreviation for barrels of water per day.

BWPH abbr: the abbreviation for barrels of water per hour; used in drilling reports.

Bypass n: a pipe connection around a valve or other control mechanism. A bypass is installed to permit passage of fluid through the line while adjustments or repairs are made on the control that is bypassed.

Calcium sulfate n: a chemical combination of calcium, sulfur, and oxygen. Calcium sulfate sometimes contaminates drilling fluids or may be added to provide special properties. It forms a tenacious scale in certain water-handling facilities. Chemical symbol is CaSO4. (See anhydrite and gypsum.)

Calibration tank n: (See prover tank.)

Casing float collar n: (See float collar.)

Casing float shoe n: (See float shoe.)

Casinghead n: a heavy, steel, flanged fitting that connects to the first string of casing (that string nearest the surface) and provides a housing for the slips and packing assemblies by which intermediate strings of casing are suspended and the annulus sealed off.

Casinghead gas n: a gas produced in association with oil.

Casinghead gasoline n: the liquid hydrocarbons that are extracted from casinghead gas.

Casing point n: the depth in a well at which casing is set. Generally, the casing point is the depth at which the casing shoe resides.

Casing pressure n: the pressure that is built up in a well between the casing and tubing or casing and drill pipe.

Casing shoe n: a short, heavy, hollow, cylindrical steel section, beveled on the bottom edge, that is placed on the end of the casing string to serve as a reinforcing shoe and to aid in cutting off minor projections from the borehole wall as the casing is being lowered. Casing shoes may have chisellike projections on the bottom edge for a more effective cutting action.

Cement n: a powder consisting basically of alumina, silica, lime, etc., which, when mixed with water, hardens by chemical action. The cement used in the oil industry is that called common cement, or portland cement. The quantity of cement used in a well is commonly referred to as a given number of sacks. In North American oil operations, a sack consists of 94 lb of cement. Although most cement is handled in bulk, the term sack persists to indicate a definite quantity of cement.

Cement additive n: a material added to cement at the time of cementing a well to change its properties. Chemical accelerators, chemical retarders, and weight-reduction materials are among the common additives. (See cementing materials.)

Cementing n: the application of a liquid slurry of cement and water to various points in an oil well, inside or outside the casing. (See primary cementing, secondary cementing, and squeeze cementing.)

CFG abbr: the abbreviation for cubic feet of gas; used in drilling reports.

CFGPD abbr: the abbreviation for cubic feet of gas per day; used in drilling reports.

Choke n: a type of orifice installed in a line for the purpose of restricting the flow and controlling the rate of production. Surface chokes are a part of the Christmas tree and contain a choke nipple, or bean, with a small-diameter bore (an orifice) that serves to restrict the flow. Also, chokes are used to control the rate of flow of the drilling mud out of the hole when the well is closed in with the blowout preventer and a kick is being circulated out of the hole. (See adjustable choke, bottom-hole choke, and positive choke.)

Clean out v: to remove sand, scale, and other deposits from the producing section of the well in order to restore or to increase production.

Close in v: to temporarily shut in a well that is capable of producing oil or gas; to close the blowout preventers on a well that is being drilled in order to control a kick. The blowout preventers close off the annulus so that pressure from below cannot flow to the surface.

Commercial production n: a production of a sufficient quantity of oil or gas to justify keeping the well in production.

Commercial quantity n: a quantity of oil or gas sufficient for production in paying quantities (i.e., there are enough hydrocarbons available in the reservoir to make it profitable to go the expense of producing them).

Commingling n: the mixing together of crude oil or oil products that have similar properties. Sometimes products of similar characteristics are mixed together in a single pipeline for convenience.

Common carrier n: any transportation system available for use by the public for transporting cargo. Almost all pipelines are common carriers.

Complete a well v: to finish the work on a well and bring it to productive status. (See well completion.)

Completion n: a well completion.

Compound n: the mechanism for transmitting power from the engines to the pump, drawworks, and other machinery on a drilling rig. A compound is composed of clutches, chains and sprockets, belts and pulleys, and a number of shafts, both driving and being driven.

Compressor n: a device that raises the pressure of a compressible fluid, such as air or gas. Compressors create a pressure differential in order to move or compress a vapor or a gas, consuming power in the process. They may be broadly classified as positive-displacement or nonpositive-displacement machines according to whether or not there is incorporated in the compressor a mechanism functioning in the manner of a check valve to separate the high-pressure discharge from the low-pressure suction. Nonpositive-displacement compressors contain no parts having this function. (See centrifugal compressor and reciprocating compressor.)

Condensate n: a light hydrocarbon liquid obtained by condensation of hydrocarbon vapors. It consists of varying proportions of butane, propane, pentane, and fractions heavier than these and contains little or no ethane and methane.

Condensate reservoir n: a reservoir in which both condensate and gas may exist as one homogeneous phase. When fluid is drawn from such a reservoir and the pressure decreases below the critical level, a liquid phase (condensate) makes its appearance.

Condition v: to treat drilling mud with additives to give it the desired properties; sometimes applied to treatment

of water for use in boilers, in drilling operations, etc. To condition and circulate mud refers to the fact that it is necessary to circulate the mud through the mud system while conditioning with additives to distribute the additives uniformly throughout all the mud in the system.

Connection n: a place in electrical circuits where wires join together; a section of pipe or a fitting used to join pipe to pipe or pipe to a vessel. (See make a connection.)

Conservation n: a preservation or saving; the avoidance of waste. The term is of special significance to the petroleum industry since oil is an irreplaceable substance. Conservation in the oil industry may refer to any of the following: prevention of escape to the atmosphere of condensable vapors; returning produced gas to the reservoir; or producing oil with the use of as little gas energy as possible.

Continuous phase n: the liquid surrounding solids suspended in a liquid or droplets of one liquid dispersed in another; may be called external phase. The solids or droplets of liquid are the discontinuous phase, or internal phase. In a water-in-oil emulsion, the oil is the continuous phase and the water is the discontinuous phase.

Contour map n: a map consisting of a number of contours (a line on which every point is at the same elevation above or below sea level) of a given area. Structure contour maps are used by geologists to depict subsurface features.

Contract n: an agreement, usually written, covering the terms under which services are to be performed. A drilling contract covers the price of drilling the well (whether by foot or by day), the type of equipment to be used, the distribution of expenses between the operator and the contractor, and other pertinent provisions.

Correlate v: to relate the subsurface information obtained for geological information from one well to that of others in such a manner that the formations may be charted graphically and their depths and thicknesses noted. Correlations are made by comparing electrical well logs, radioactivity logs, and cores from different wells.

Counterbalance weight n: a weight applied to compensate for existing weight or force. On pumping units in oil production, counterweights are used to offset the weight of the column of sucker rods and oil on the upstroke of the pump and the weight of the rods on the downstroke. The proper application or adjustment of the counterweights is a more complex problem than it appears. Extra effort to attain correct counterbalance can increase pumping efficiency and eliminate mechanical problems having to do with the pump and sucker rods.

Crude oil n: the liquid petroleum before it is refined. Crude oil is customarily described in terms of its gravity, base, color, and sulfur content. Gravities range from about 9 to 55 API. Crudes may be paraffin base, intermediate base, or naphthene base and of colors ranging from yellowish to black. If a crude contains appreciable quantities of sulfur or sulfur compounds, it is called a sour crude; if it contains little or no sulfur, it is called a sweet crude. Crude oils are often referred to as heavy crudes or light crudes, according to their API gravities, the lighter oils having higher API gravities.

Cryogenics n: the study of the effects of very low temperatures. In some cases, cryogenic temperatures are used in the processing of natural gas.

cu abbr: the abbreviation for cubic.

Cubic centimeter (cm3) abbr: a metric system unit for the measure of volume; one one-hundredth of a cubic meter. One cm3 is approximately equal to 0.061 in.3

Cubic foot (cu ft, cf, ft3) n: the volume of material contained in a cube all edges of which measure 1 ft in length. Natural gas in North America is commonly measured in units of cubic feet, the standard cubic foot being such a unit of gas measured at temperature and pressure conditions accepted as standard in various areas and by various companies--usually at a temperature of 60 F at 14.65 psia. Abbreviations are cu ft, cf, ft3.

Dead well n: a well that has ceased to produce oil or gas, either temporarily or permanently; a well that has kicked and has been killed.

Deplete v: to exhaust the supply. An oil and gas reservoir is depleted when most or all recoverable hydrocarbons have been produced.

Depth n: the vertical distance to which a well is to be drilled; stipulated in a drilling contract as contract depth. Total depth is the depth of the well after drilling is finished. On offshore drilling rigs, the distance from the baseline of a rig or ship to the uppermost continuous deck.

Discovery well n: the first oil or gas well drilled in a new field. The discovery well is the well that is drilled to reveal the actual presence of a petroleum-bearing reservoir. Subsequent wells are development wells.

Disposal well n: a well into which salt water is pumped. Usually such wells are part of a saltwater-disposal system. (See saltwater disposal.)

Distribution n: the process of apportionment of daily production, the daily production is attributed to the many wells on a lease on the basis of periodic tests rather than on segregated receiving and gauging of the oil from each well separately. This is called distribution of the production. The common expression is "distribution of the daily production back to the wells."

Dolo abbr: the abbreviation for dolomite; used in drilling reports.

Dolomite n: a type of sedimentary rock similar to limestone but rich in magnesium carbonate. Sometimes dolomite is found as the reservoir rock for petroleum.

Downhole adj: descriptive of that which is used in the wellbore. For example, a downhole tool is used in the wellbore.

Dry gas n: a natural gas that is comprised primarily of light hydrocarbon vapors, such vapors not tending to liquefy under those temperature and pressure conditions usually encountered in the reservoir or at the wellhead; gas from which water has been removed.

Dump tank n: a calibrated metering tank that is designed to release automatically an accurate volume of liquid; also called a measuring tank.

Dump valve n: the discharge valve through which oil and water are discharged from separators, treaters, etc. It is usually a motor valve and in another service may be called a liquid-level controller.

Emulsified water n: the water that is combined with oil such that special treating methods must be applied in order to separate it from the oil. Compare with free water.

Emulsion n: a mixture consisting of one liquid, called the dispersed phase, more or less uniformly distributed as minute globules in another liquid, called the dispersion medium, or continuous phase. In an oil-water emulsion, the oil is the dispersed phase and the water is the dispersion medium. Water is the dispersed phase in a in a water-oil emulsion, being dispersed as globules in a medium of oil. The water-oil emulsion is a typical product of oil wells and is one of several emulsions being used as a drilling fluid in the petroleum industry.

Emulsion breaker n: a system, device or process used for breaking down an emulsion and rendering it into two or more easily separated compounds (as water and oil). Emulsion breakers may be (1) devices for heating the emulsion, in which case the separation of oil and water is achieved by lowering the viscosity of the emulsion and allowing the water globules to settle out; (2) chemical compounds, which are chosen for their ability to destroy or weaken the film around the globule of water, thus allowing individual globules to unite; (3) mechanical devices (as settling tanks and wash tanks); and (4) electrostatic treaters, which use an intense electric field to cause coalescence of water globules, also known as electric dehydration.

Emulsion test n: a procedure carried out to determine the proportions of sediment and dispersed components in an emulsion. Such a test may range from elaborate distillation procedures conducted in a laboratory to simple and expediant practices in the field.

Emulsion treating n: the process of breaking down emulsions to bring about a separation of the oil from the water and other contaminants. Treating plants may employ a single process or a combination of processes to effect demulsification, depending on the nature of the emulsion to be treated.

Encroachment n: (See water encroachment.)

Enhanced recovery n: a method or methods applied to depleted reservoirs in order to make them once again productive. After an oil well has reached depletion, there still remains a certain amount of oil in the reservoir. Enhanced recovery refers to any method or methods used to produce this remaining oil. (See secondary recovery and tertiary recovery.)

Est abbr: the abbreviation for estimated; used in drilling reports.

Ethane n: a light hydrocarbon, $C_2H_6$, associated with petroleum. It is a gas at atmospheric conditions.

Field n: a geographical area in which a number of oil or gas wells produce from a continuous reservoir. The term generally refers to the surface area, although at times it may refer to both the surface and the underground productive formations. In a single field there may be several separate reservoirs at varying depths.

Flare n: an arrangement of piping and a burner to dispose of surplus combustible vapors that is situated around a gasoline plant, refinery, or producing well.

Flare v: to dispose of surplus combustible vapors by igniting the vapors in the atmosphere. Currently, not much flaring of gas occurs because of the high value of the gas and because of the more stringent pollution controls.

Flood v: to drown out a well with water; to drive oil from the reservoir into the well by water introduced under pressure into the reservoir formation. (See water flood.)

Flow by heads v: to produce intermittently. When a well produces intermittently, it is said to be flowing by heads.

Flow chart n: a record that is made by a recording meter that shows the rate of production.

Flowing pressure n: the pressure registered at the wellhead of a flowing well.

Flowing well n: a well that produces oil or gas by its own reservoir pressure; a well that is not being produced by the employment of pumps or other artificial means.

Flow line n: the surface pipe through which oil travels from the well to processing equipment or storage.

Flow-line treating v: the process by which an emulsion is separated, or broken into oil and water in a vessel or tank on a continuous basis without interruption in the flow of emulsion into the tank or vessel. Compare with batch treating.

Flow-line treater n: a vertical or horizontal cylindrical vessel into which emulsion is run so that it can be resolved to oil, water, and gas. (See heater-treater and electrostatic treater.)

Flow meter n: a device that measures the amount of fluid moving through a pipe. (See orifice meter and positive-displacement meter.)

Flow tank n: the storage tank to which produced oil is run.

Flow treater n: a single unit that acts as an oil and gas separater, an oil heater, and an oil- and water-treating vessel; often called a heater-treater.

Fluid n: a substance that flows. A fluid yields to any force tending to change its shape; both liquids and gases are fluids.

Fluid contact n: the approximate point in a reservoir where the oil and gas come into contact (gas-oil contact) or where the oil and water come into contact (oil-water contact.)

Fluid level n: the distance from the surface to the top of the liquid in the tubing or casing in a well. The static fluid level is taken when the well is not producing and after it has stabilized. The dynamic, or pumping, level is the point to which the static level is lowered under producing conditions.

Fluid loss n: the migration of the liquid part of the drilling mud into a formation. Fluid loss usually is not desirable, and many things are added to the drilling mud to prevent or minimize its occurrence.

Fluid-loss additive n: a compound placed in cement slurry or drilling mud that is used to prevent or minimize fluid loss.

Fluid pound n: the impact of a pump plunger on the fluid when the pump is operating with a partial vacuum in the cylinder, with gas trapped there, or with the well pumping off. (See pump off.)

Formation n: a bed or deposit composed substantially of the same kinds of rock throughout; a lithologic unit. In oil areas each formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on the fossils found in the formation.

Formation water n: the water originally in place in a formation. (See connate water.)

Gal abbr: the abbreviation for gallon.

Gallon (gal) n: a unit of measure of liquid capacity. One gal equals 3.785 liters and has a volume of 231 in3. A gallon of water weighs 8.34 lb at 60 F. An imperial gallon is equal to approximately 1.2 U.S. gal and is used in Great Britain.

Gal/min abbr: the abbreviation for gallons per minute.

Gamma-Gamma Density Log n: a trade name for a density log.

Gas n: a fluid substance that completely fills any container in which it is confined and whose volume is dependent on the size of and the pressure exerted upon the container. A gas is compressible.

Gas anchor n: a tubular, perforated device that is attached to the bottom of a sucker-rod pump and serves to prevent failure of the pump (gas lock) because of gas entry into the pump. The device works on the principle that gas is lighter than oil and rises. As well fluids enter the anchor, the gas breaks out of the fluid and exits the anchor through perforations near the top. The remaining fluids enter the pump through a mosquito bill (a tube within the anchor), which has an opening near the bottom of the anchor. In this way, all or most of the gas is given the opportunity to escape before the fluids entér the pump.

Gas cap n: the free-gas phase overlying an oil zone and that occurs within the same producing formation as oil. (See reservoir.)

Gas-cap drive n: the drive energy supplied naturally by the expansion of gas in a cap overlying the oil in a reservoir as the reservoir is produced. (See reservoir-drive mechanism.)

Gas drive n: the application of the energy of compressed gas in a reservoir to move crude oil to a wellbore. Gas drive is also utilized in a form of secondary recovery, wherein gas is injected into input wells to sweep the oil to a producing well. (See secondary recovery and reservoir.)

Gasket n: any material (as paper, cork, asbestos, rubber, etc.) that is used to seal two essentially stationary surfaces.

Gas lift n: the process of raising, or lifting, fluid from a well by means of gas injected down the well through tubing or through the tubing-casing annulus. Injected gas aerates the fluid to make it exert less pressure than the formation pressure. Consequently, the higher formation pressure forces the fluid out of the wellbore. Gas may be injected continuously or intermittently, depending on the producing characteristics of the well and the arrangement of gas-lift equipment.

Gas-lift valve n: a device installed on the tubing string of a gas-lift well that is sensitive to tubing and casing pressures, such pressures causing the valve is to allow gas to be injected into the fluid in the tubing in order to cause the fluid to rise to the surface.

Gas liquids n pl: (See liquefied petroleum gas.)

Gas-oil ratio (GOR) n: a measure of the volume of gas produced with the oil; expressed in cubic feet per barrel or in cubic meters per metric ton.

Gasoline n: a volatile, flammable liquid hydrocarbon that is refined from crude oils and finds wide use as a fuel for internal-combustion, spark-ignition engines.

Gas plant n: an installation in which natural gas is processed by being passed through a number of special items of equipment; a gas plant prepares gas from the field to be sold to consumers. Because natural gas is a hydrocarbon mixture plus any impurities, a gas plant separates the desirable hydrocarbon components and removes most or all of the impurities.

Gas regulator n: a device for controlling the pressure of gas flowing in a pipeline. A regulator is essentially an automatically operated valve that, by opening and closing in response to pressure, permits more or less gas to flow through and thus controls the pressure.

Gas sand n: a stratum of sand or porous sandstone from which natural gas is obtained.

Gas-transmission system n: the central, or trunk, pipeline system by means of which dry natural gas is transported from field gathering stations or processing plants to the industrial or domestic fuel market. Well pressure is supplemented at intervals along the transmission pipeline by compressors in order to maintain the flow of gas to its destination.

Gone to water adj: descriptive of a well in which oil production has decreased and the production of water has greatly increased (e.g. "the well has gone to water").

Gross production n: the total production of oil from a well or lease during a specified period of time.

Guidelines n pl: lines (usually four) attached to the temporary guide base and permanent guide base that serve as a means to accurately position equipment (as the blowout preventers) on the ocean floor when an offshore well is being drilled.

Gypsum n: a naturally occurring crystalline form of calcium sulfate combined with two molecules of water. (See calcium sulfate and anhydrite.)

Heater n: a container or vessel enclosing an arrangement of tubes and a firebox in which an emulsion is heated prior to further treating procedures. Natural gas is heated to control the formation of hydrates, and a product is heated for any purpose.

Heater-treater n: a vessel in which an emulsion is placed in order to heat the emulsion remove water and gas, render oil of acceptable quality to a pipeline. Heater-treaters are a combination of a heater, free-water knockout, and oil and gas separator.

Hot Oil n: an oil produced in violation of state regulations or transported interstate in violation of federal regulations.

Hot-oil treatment n: the treatment of a producing well with heated oil so as to melt out accumulated paraffin in the tubing and annulus.

Hydrocarbons n: organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed only of carbon and hydrogen, hydrocarbons exist in a great variety of compounds, owing to the strong affinity of the carbon atom for other atoms and for itself. The smallest molecules are gaseous; the largest are solids. Petroleum is a mixture of many different hydrocarbons.

Independent n: nonintegrated producing company in the oil industry. The integrated company usually operates production, transportation, refining, and marketing facilities. The independent producer has operations, as a rule, only in the field of petroleum production.

Initial potential (IP) n: the initial production of an oil well recorded after testing operations and recovery of load oil. For this figure to be meaningful, it should approximate closely the maximum ability of a well to produce on completion without subsequent reservoir damage.

Initial set n: the point in time when a cement slurry begins to harden, or set up, and is no longer pumpable.

Injection pattern n: the spacing and pattern of wells in a secondary-recovery or pressure-maintenance project determined from the location of existing wells, nature of offset operations, reservoir size and shape, and the cost of drilling new wells. The more common injection patterns include line drive, five spot, seven spot, nine spot, and peripheral.

Injection pump n: a chemical feed pump that injects chemical reagents into a flow-line system at a rate proportional to the rate of flow of the well fluid for the purpose of treating emulsions. Operating power may be derived from electric motors; from gas-driven, diaphragm-operated motors; or by linkage with the walking beam of a pumping well.

Intermediate casing string n: the string of casing set in a well after the surface casing. Its purpose is to keep the hole from caving and, sometimes, to afford a strong string of pipe to which blowout preventers can be attached. This casing string is sometimes called protection casing.

Intermitter n: a device for regulating the production of a flowing well whereby the well flows wide open (not through a choke) for short periods of time and is then closed in. This action is repeated several times a day.

LACT abbr: the abbreviation for lease automatic custody transfer and most often spoken as a single word, "lact." A LACT unit is an automated system for measuring and transferring oil from a lease gathering system into a pipeline.

LACT unit n: (See lease automatic custody transfer and LACT.)

Land n: that area of a aprtly machined surface (as with grooves or indentations) that is left without such machining; the area between the grooves into which the rings fit on a piston.

Lease n: a legal document executed between the landowner or lessor and another party as lessee that grants the right to exploit the premises for minerals or other products. Also, the lease is the place on which production wells, stock tanks, separators, LACT units, and other production equipment are located.

Lessee n: the recipient of a lease (as a oil and gas lease).

Lessor n: the conveyer of a lease (as an oil and gas lease).

Liquefied natural gas (LNG) n: a liquid composed chiefly of natural gas (that is, mostly methane); natural gas is liquefied for the purpose of transporting it where a pipeline is not feasible (as across the oceans in tank ships). Not as easily liquefied as LPG, LNG must be put under low temperature and high pressure in order to liquify it.

Liquefied petroleum gas (LPG) n: a mixture of heavier, gaseous, paraffinic hydrocarbons, principally butane and propane. These gases are easily liquified at moderate pressures and may be transported as liquids but converted to gases on release of the pressure. For this reason, liquefied petroleum gas is a portable source of thermal energy that finds wide application in arease where it is impracticable to distribute natural gas. It is also used as a fuel for internal-combustion engines and has many industrial and domestic uses. Principal sources are natural gas and refinery gas, from which the liquefied petroleum gases are separated by fractionation.

Liquid n: a state of matter in which the shape of the given mass depends on the containing vessel but the volume of the mass is independent of the vessel. A liquid is a practically incompressible fluid.

Location n: the place at which a well is to be or is being drilled.

Measuring device n: a special reel and power arrangement for single-stranded wire line to make depth measurements in

a well. A calibrated wheel and roller assembly is used to measure the footageof wire line as it is lowered into the well.

Microlog n: the brand name for a special electric-survey method whereby three closely spaced electrodes are pressed against the wall of the borehole to obtain a measurement of formation characteristics very near the wall of the hole.

Multiple well-pumping system n: a system of oil lifting that is designed to be operated on several wells in a coordinated manner. The system may be composed of rod and pump units or a hydraulic pumping installation.

Natural gas n: a highly compressible, highly expansible mixture of paraffin hydrocarbons having a definite specific gravity and occurring naturally in a gaseous form. The principal component gases of natural gas, along with approximate percentages are--

| | |
|---|---|
| methane | 80.0% |
| ethane | 7.0% |
| propane | 6.0% |
| isobutane | 1.5% |
| butane | 2.5% |
| pentane plus | 3.0% |

In addition to these gases, natural gas may contain appreciable quantities of nitrogen, helium, carbon dioxide, and contaminants (as hydrogen sulfide and water vapor). Although gaseous at normal temperatures and pressures, certain of the gases comprising the mixture that is natural gas are variable in form and may be found either as gases or as liquids under suitable conditions of temperature and pressure.

Natural gasoline n: the liquid hydrocarbons recovered from wet natural gas; often called casinghead gasoline.

Net production n: the amount of oil produced by a well or lease, exclusive of its BS&W content. A company's net production is also called its working-interest oil (i.e., the net oil produced by all of its wells multiplied by the company's working interest in the wells).

Occupational Safety and Health Administration (OSHA) n: an agency of the U.S. government that establishes safety standards and their enforcement for those employed by industry; usually abbreviated OSHA.

Off-production adj: descriptive of a well when it is shut in or temporarily not able to produce.

Oil and gas separator n: an item of production equipment used to separate the liquid components of the well stream from the gaseous components. Separators may be vertical or horizontal, cylindrical vessels, or they may be spherical in shape. Separation of the oil and gas is accomplished principally by gravity, the heavier liquids falling to the bottom and the gas rising to the top. The gas leaves from the top of the separator, and the oil leaves from the bottom. A float valve or other liquid-level control regulates the level of oil in the bottom of the separator.

Oil sand n: in the strict sense, sandstone that yields oil, but used generally to include practically any reservior that yields oil.

Oil seep n: a surface location where oil appears, permeating from its subsurface boundaries and accumulating in a small pool.

Oil shale n: a formation containing hydrocarbons that cannot be recovered by an ordinary oil well but that may be mined and, on processing, the hydrocarbons extracted. Up to now, the cost of mining and treatment of oil shale has been too great to compete with the price of oil from wells; however, this is rapidly changing.

Oil spill n: a quantity of oil that has leaked or fallen onto the ground or onto the surface of a body of water.

Oil string n: the final string of casing set in a well after the productive capacity of the formation has been assured; also called the long string or the production casing.

Oil-water contact n: the point or plane where the bottom of an oil sand contacts the top of a water sand in a reservior; sometimes termed the oil-water interface.

Oil-well pump n: any pump, surface or subsurface, that is used as a means of lifting fluids from the reservior to the surface. (See sucker-rod pumping and hydraulic pumping.)

On-the-line adj: descriptive of a tank that is being emptied into a pipeline.

On-the-pump adj: descriptive of a well that is being pumped.

Packer n: a piece of downhole equipment consisting essentially of a sealing device, a holding or setting device, and an inside passage for fluids. It is used to block the flow of fluids through the annular space between the tubing and the wall of the wellbore by sealing off the space between them. Usually made up in the tubing string some distance above the producing zone, the packer is set, and a sealing element expands to prevent fluid flow except through the inside bore of the packer and into the tubing. Packers are classified according to their configuration, use, and method of setting and whether they are retrievable or permanent (that is, whether they can be removed when necessary, or whether they must be milled or drilled out and thus destroyed).

Parraffin n: a hydrocarbon having the formula $C_nH_{2n+2}$ (e.g., methane, $CH_4$, ethane, $C_2H_6$; etc.). Heavier paraffin hydrocarbons (i.e., those of $C_{16}H_{34}$ and heavier) form a waxlike substance that is called paraffin. These heavier paraffins often accumulate on the walls of tubing and other production equipment, thus restricting or stopping the flow of desirable lighter paraffins.

Paraffin-base oil n: a crude oil characterized by a high API gravity, a high yield of low-octane gasoline, and a high yield of lubricating oil having a high pour point and a high viscosity index, as compared with naphthene-base oils. Popularly, and according to an early classification system, a paraffin-base oil is a crude oil containing little or no asphalt and whose residue from distillation contains paraffin wax.

Parted rods n pl: sucker rods that have been broken and separated in a pumping well because of corrosion, improper loading, damaged rods, etc.

Pay n: (See pay sand.)

Pay sand n: the producing formation (that is, the formation that represents the objective of drilling.) Often even producing formations that are not sandstone are referred to as pay sands. Also referred to as pay, pay zone, and producing zone.

Pay zone n: (See pay sand.)

Perforate v: to pierce the casing wall and cement for the purpose of providing holes through which formation fluids may enter or for providing holes in the casing in order that materials may be introduced into the annulus between the casing and the wall of the borehole. Perforating is accomplished by lowering into the well a perforating gun, or perforator, that fires bullets or shaped charges and is fired electrically from the surface.

Perforation n: the hole made in the casing, cement, and formation through which formation fluids enter a wellbore. Usually several perforations are made at once.

Permeability n: a measure of the ease with which fluids can flow through a porous rock; the fluid conductivity of a porous medium; the ability of fluid to flow within the interconnected pore network of a porous medium. (See absolute permeability, effective permeability, and relative permeability.)

Petroleum n: the oil or gas obtained from the rocks of the earth, usually by drilling down into a reservoir rock and piping them to the surface. (See hydrocarbons.)

Pinch-out n: a geological structure that forms a trap for oil and gas by virtue of a porous and permeable rock ending or stopping against an impervious formation.

Pipeline n: a system of connected lengths of pipe, most of which is buried in the earth or laid on the seafloor, that is used for transporting petroleum and natural gas. Sometimes the word is used to include the pumps, compressors, tanks, etc., that go to make up the pipeline system.

Pipeline connection n: the outlet from a well or tank by which oil or gas is transferred to a pipeline for transportation away from the field.

Plug and abandon (P&A) v: to place a cement plug or plugs in a dry hole and abandon it.

Polished rod n: the topmost portion of a string of sucker rods, which is used for lifting fluid by the rod-pumping method. The polished rod has a uniform diameter and is smoothly polished to effectively seal pressure in the stuffing box attached to the top of a well.

Potential n: the maximum volume of oil and/or gas that a well is capable of producing.

Potential test n: a test of the rate at which a well can produce oil or gas. (See potential.)

Producing zone n: the zone or formation from which oil or gas is produced (See pay sand.)

Production; that phase of the petroleum industry that has to do with bringing the well fluids to the surface and separating them and with storing, gauging, and otherwise preparing the product for the pipeline; the amount of oil or gas produced in a given period.

Production casing n: the last string of casing or liner that is set in a well and inside of which is usually suspended the tubing string. (See oil string, and long string.)

Production log n: a well-logging method that measures and records the flow of fluid past an indicating device placed at varying depths in a producing or injection well; sometimes called a spinner survey.

Production tank n: a tank used in the field to receive crude oil as it comes from the well; also referred to as a flow tank or lease tank.

Propane n: a paraffin hydrocarbon, $C_4H_{10}$, that is a gas at ordinary atmospheric conditions but is easily liquefied under pressure. One of the constituents of LPG.

Proration n: a system enforced by a state or federal agency or by agreement between operators that limits the amount of petroleum that can be produced from a well or field within a given period.

psi abbr: the abbreviation for pounds per square inch.

Pulling unit n: a well-servicing outfit used in pulling rods and tubing from the well. (See production rig.)

Pump n: a device that increases the pressure on a fluid or raises it to a higher level. The various types of pumps include a reciprocating pump, centrifugal pump, rotary pump, jet pump, sucker-rod pump, hydraulic pump, mud pump, submersible pump, and bottom-hole pump.

Pumping unit n: the machine that imparts the reciprocating motion to a string of sucker rods extending to the positive-displacement pump at the bottom of a well; usually a beam arrangement driven by a crank attached to a speed reducer.

Pumping jack n: a surface unit similar to a pumping unit but that has no individual power plant. Usually several pump jacks are operated by pull rods or cables from one central power source.

Put on the pump v: to install a pump jack or pumping unit, sucker rods, and bottom-hole pump in a well.

Reservoir n: a subsurface, porous, and permeable rock body in which oil and/or gas is stored. Most reservoir rocks are either limestones, dolomites, sandstones, or some combination of these. The three basic types of hydrocarbon reservoirs are oil, gas, and condensate. An oil reservoir generally contains three fluids--gas, oil, and water--with oil being the dominant product. In the typical oil reservoir, these fluids occur in different phases because of the variance in their gravities. Gas (being the lightest) occupies the upper part of the reservoir rocks, water occupies the lower portion, and oil occupies the intermediate section. In addition to occurring as a gas cap or as a solution gas, gas may exist as an accumulation independent of the oil; when this holds true, the reservoir is called a gas reservoir. Associated with the gas, in most instances, is salt water and occasionally some oil. In a condensate reservoir, the hydrocarbons in the reservoir may exist as a gas under reservoir may exist as a gas under reservoir conditions, but, when brought to the surface, some of the heavier hydrocarbons condense to a liquid, or condensate. At the surface the hydrocarbons from a condensate reservoir consist of gas and a high-gravity crude (i.e., the condensate). Condensate wells are sometimes called gas-condensate reservoirs.

Run a tank v: a transfer oil from a stock tank into a pipeline.

Run ticket n: a record of oil transferred from the producer's storage tank to the pipeline. This is the basic legal instrument by which the lease operator is paid for oil produced and sold.

Sanded-up adj: descriptive of a well in which production has been restricted because of sand accumulation in the wellbore; descriptive of equipment in which sand has accumulated so as to greatly impede its operation.

Sand fill n: a column of sand that has entered and accumulated in the wellbore.

Shut in v: to close the valves on a well so that it stops producing; said of a well on which the valves are closed. Also, to close in a well in which a kick has occurred.

Shut-in bottom-hole pressure n: the pressure existing at the bottom of a well when the surface valves on the well are completely closed. This pressure is caused by fluids that may exist in the formation or formations at the bottom of the well.

Shut-in pressure n: the pressure noted on a gauge installed on the surface control valves when the well is completely shut in. When drilling is in progress, this pressure should be zero because the pressure exerted by the drilling fluid should be equal to or above the pressure exerted by the formations through which the wellbore passes. On a flowing producing well, however, shut-in pressure should be some valve above zero.

Sour crude n: a shortened form of sour crude oil.

Sour crude oil n: an oil containing hydrogen sulfide or other sulfur compounds.

Specific gravity n: the ratio of the weight of a given volume of a substance at a given temperature to the weight of an equal volume of a standard substance at the same temperature. For example, if 1 $in.^3$ of water at 39 F weighs 1 unit, and 1 $in.^3$ of another solid or liquid at 39F weighs 0.95 units, then the specific gravity of the substance is 0.95. In determining the specific gravity of gases, the comparison is made with air or hydrogen. (See gravity.)

Stuffing box n: a packing gland screwed in the top of the well head through which the polished rod operates on a pumping well. It prevents the escape of oil, diverting it into a side outlet to which is connected the flow line leading to the oil and gas separator or to the field storage tank.

Tank n: a metal, plastic, or wooden container for the storage of a liquid. In the petroleum industry, there are two types of tanks, classified according to the general purpose of the tank. Production tanks are those used in the producing fields to receive crude oil as it comes from the well. Storage tanks are designed for the storage and handling of large volumes of oil at large pipeline stations. In general, storage tanks are larger and of appreciably stronger construction than production tanks.

Tank battery n: a group of production tanks located at a point in the field for the storage of crude oil.

Tank bottoms n pl: the settlings in storage tanks. (See basic sediment and water and bottom .)

Temperature survey n: an operation to determine temperatures at various depths in the wellbore. This survey is used to determine the height of cement behind the casing when there is doubt as to the height, to find the location of water influx into the wellbore, and for other reasons.

Temporarily abandoned adj: descrptive of a well that has been temporarily shut in but not plugged.

Total depth (TD) n: the maximum depth reached in a well.

Tubingless completion n: a method of producing a well by which only a small-diameter production casing is set through the pay zone, with no tubing or inner production string employed to bring formation fluids to the surface. This type of completion has limited application in small-volume, dry-gas reservoirs.

Unit operator n: an oil company that is in charge of the development and producing operations in an oil field in which several companies have joined together to provide funds, engineering expertise, etc., to produce the fluid.

USGS abbr: the abbreviation for United States Geological Survey. USGS is responsible for the enforcement of rules pertaining to the drilling and production of oil and gas in offshore areas of the United States.

Vacuum n: a space devoid of all matter; hence, said space exerts zero pressure (theoretical). However, vacuum is commonly used to describe a condition that exists in a system when pressure is reduced below atmospheric pressure.

Vent n: an opening in a vessel, line, or pump to permit the escape of air or gas.

Well spacing N: the regulation of the number and location of wells over a reservoir as a conservation measure.

Working interest n: the portion of oil production out of which operating and development costs are paid (i.e., portion remaining after deduction of royalty interest).

Working-interest oil n: (See net production and working interest.)

Work over v: to perform one or more of a variety of remedial operations on a producing oil well with the hope of restoring or increasing production. Examples of workover operations are deepening, plugging back, pulling and resetting the liner, squeeze cementing, or other work involved in changing the producing interval in a well.

Workover rig n: (See production rig and pulling unit.)

Zone n: a term used to distinguish different rock strata (as shale zone, pay zone, etc.)

SOLAR ENERGY RESEARCH

SOLAR ENERGY RESEARCH SECRETARY

You are employed as Research Secretary in the Solar Energy program, the major portion of your duties will be typing technical reports. (EXHIBIT A)

So that you may become familiar with the Solar Energy Research program, the following pages will explain the Solar Total Energy Program as researched through Sandia Laboratories, Albuquerque, New Mexico.

## SOLAR ENERGY RESEARCH

### OBJECTIVES

The goal of the national Solar Energy Program is to establish solar energy as a practical and economical alternative to depletable fuels in widespread residential, commercial, industrial, and governmental applications. Sandia Laboratories assists the Department of Energy (DOE) toward this goal by managing technical programs, operating special-purpose solar experimental facilities, and conducting in-house scientific and engineering research. The projects we are now pursuing generally involve long range, technically difficult solar energy collection and conversion systems whose problems best match the capabilities of Sandia. The small effort we have in near-term applications such as solar heating and cooling does not reflect a judgment about their merits--but rather indicates that other groups are effectively pursuing them.

New knowledge and information, not just operating systems, are the principal "products" of our work in all solar energy projects. Therefore, an essential part of our work is the successful transfer of knowledge we have gained about solar energy to appropriate users in solar component design, system engineering, and equipment commercialization. Methods of transferring technology include direct contracts to industry, publications and workshops, public briefings

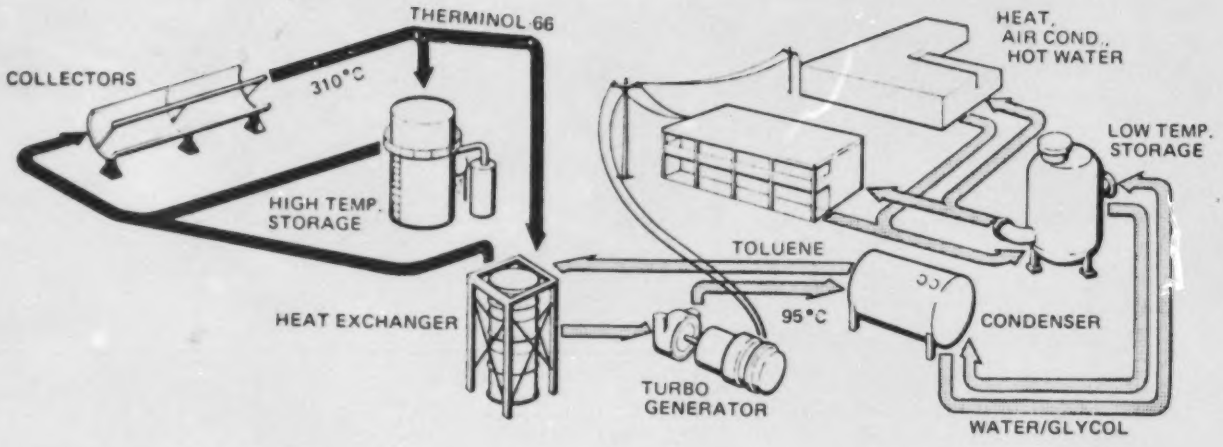
and tours, and a resident engineer program that enables industry representatives to work side-by-side with our technicians and engineers.

# Solar Total Energy Program

Technical Plan and Objectives. Solar Total Energy is one class of onsite power system being investigated and developed under the Solar Thermal Power Systems Program of DOE.

Total Energy is a system concept that provides both the low-grade (low-temperature thermal) and the high-grade (electrical and Mechanical) energy needs of selected applications. For example, this can be accomplished by operating a thermodynamic power conversion cycle using the rejected heat from electrical generation. Heat collected by solar collectors, a major contributor to overall system cost, can thereby be more effectively utilized. A solar total energy system is shown in the accompanying diagram.

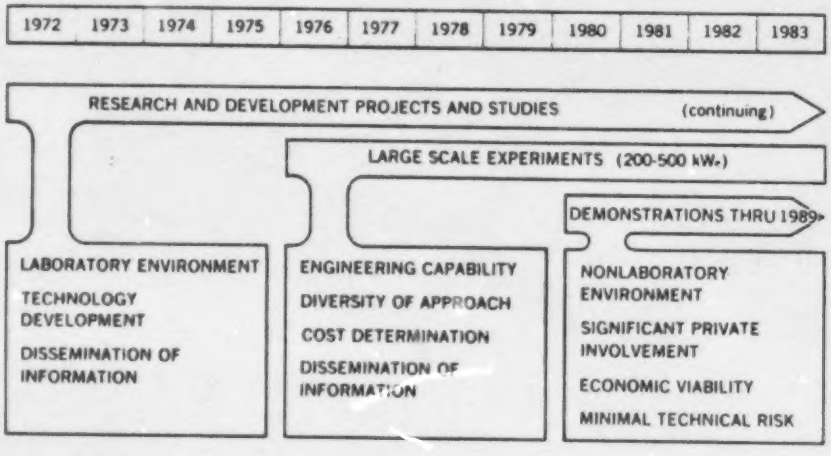
The national Solar Total Energy Program (STEP) has as its overall objectives to demonstrate the technical, economic, and institutional feasibility of the Solar Total Energy (STE) concept and to promote within appropriate private sectors a technology base that promises to be economically competitive with nonrenewable energy sources. The implementation plan in the accompanying schedule envisions the design, construction, and operation of a number of Solar Total Energy (STE)




Functional diagram defines operation of solar total energy system

demonstrations in applications representative of substantial portions of the national energy market. To provide the technical basis for these demonstrations, and as an effort to accelerate the technological development while minimizing associated programmatic risk, the Solar Total Energy Program presently consists of four major areas of activities: Application Studies, Component and Subsystem Development, Test Facilities, and Large-Scale Experiments. Application studies identify market sectors that can be penetrated by solar total

Development and implementation of the large-scale experiments and demonstrations are time-phased over the next several years



energy. Component and Subsystem Development support engineering development of the basic elements of solar total energy systems. Test Facilities operations support the previous activity by acquiring performance and cost data and by accumulating operating and maintenance experience. The Large-Scale Experiments are goal-oriented projects that result in industry teams designing and operating solar total energy systems for real applications and real customers.

As technical projects manager of the national Solar Total Energy Program, Sandia assists in all the above tasks. Component development and total energy system test facility operations are described in the following section. A series of large-scale experiments is being implemented by DOE, with Sandia providing technical management support. Westinghouse Electric Corporation is designing a solar total energy system for part of a 1500-man barracks complex at Ft. Hood, TX. The 40,700 $m^2$ (438,000 $ft^2$) complex includes barracks, commander's office, administration building, gymnasium, storage, support buildings, and a central energy facility. The conceptual design is based on a parabolic trough collector, multitank storage, and steam Rankine power conversion cycle.

A second large-scale experiment in Shenandoah, GA, is incorporating a solar total energy system in a new knitwear factory. The 2300 $m^2$ (23,000 $ft^2$) plant will initially employ 70 people, later expanding to 3900 $m^2$ (42,000 $ft^2$) and 300 employees. The solar energy system there is designed to

generate 1.25 megawatts thermal (MWth) and 250 kilowatts electrical (kWe) power. With this capacity, the system will supply 300 F process steam in addition to normal electrical, heating, air-conditioning, and hot-water requirements. General Electric Company, the contractor selected competitively to design the project, will utilize an array of parabolic dish collectors, dual media (rock and oil) storage, and steam Rankine power conversion cycle.

Other large-scale experiments are being planned. These experiments, conducted over specific time spans, will provide a data base for evaluating system and component performance in actual operating environments. DOE will then have a basis for assessing the economic practicality of large systems, and users can determine the value of solar total energy in reducing energy costs. The experiments will also develop industry's capability for manufacturing the installing solar components and provide a base of engineering system design capability.

Midtemperature Solar Systems Test Facility and Component Development. To permit selection of subsystems, components, and operational strategies for these STE projects, candidates must be developed and evaluated. The Midtemperature Solar Systems Test Facility (MSSTF) was established by the DOE to be the national test facility for the Solar Total Energy Program. The purposes of the test facility are to

(1) sponsor the design and construction of prototype hardware systems,

(2) evaluate those systems and components,

(3) study system integration considerations,

(4) accumulate experience, technical and cost data for solar total energy and dispersed power systems,

(5) distribute technical, cost, and maintenance information gained from the testing to potential participants in the Solar Total Energy Program, and

(6) give "hands-on" experience to industrial engineers, technicians, and operators.

The MSSTF comprises two separate facilities, a Collector Module Test Facility (CMTF) and a System Test Facility (STF). The CMTF is designed to obtain thermal and optical performance data for prototype collectors of up to about 45 $m^2$ (500 $ft^2$) in aperture. This facility presently incorporates three separately controlled fluid loops capable of testing three different collectors simultaneously. The three test stations use Therminol-66 heat-transfer oil to 315°C (600°F), high-pressure water to 330°C (630°F) and 18.3 MPa (2650 psi), and low-pressure water to 110°C (230°F) and 0.51 MPa (75 psi). This latter loop is being modified to provide additional capability to test with heat-transfer oils. This time required to complete testing of a collector ranges from 3-10 wk, depending on the weather, the nature of the collector, and the complexity of the test plan. After each test, a report that contains test efficiency data, heat-loss data, and all pertinent information relative to assembly, operation, and maintenance of the prototype collector is issued to wide distribution. These reports are assembled into a summary report semiannually.

Prototype collectors are either developed or purchased for testing to obtain performance data and to identify potential design improvements. Currently companies providing collectors include Hexcel, Soltrax, Scientific Atlanta, Solar Kinetics, FMC, Del-Jacobs, GE, Itek, McDonnell Douglas, General Atomic, and Suntec.

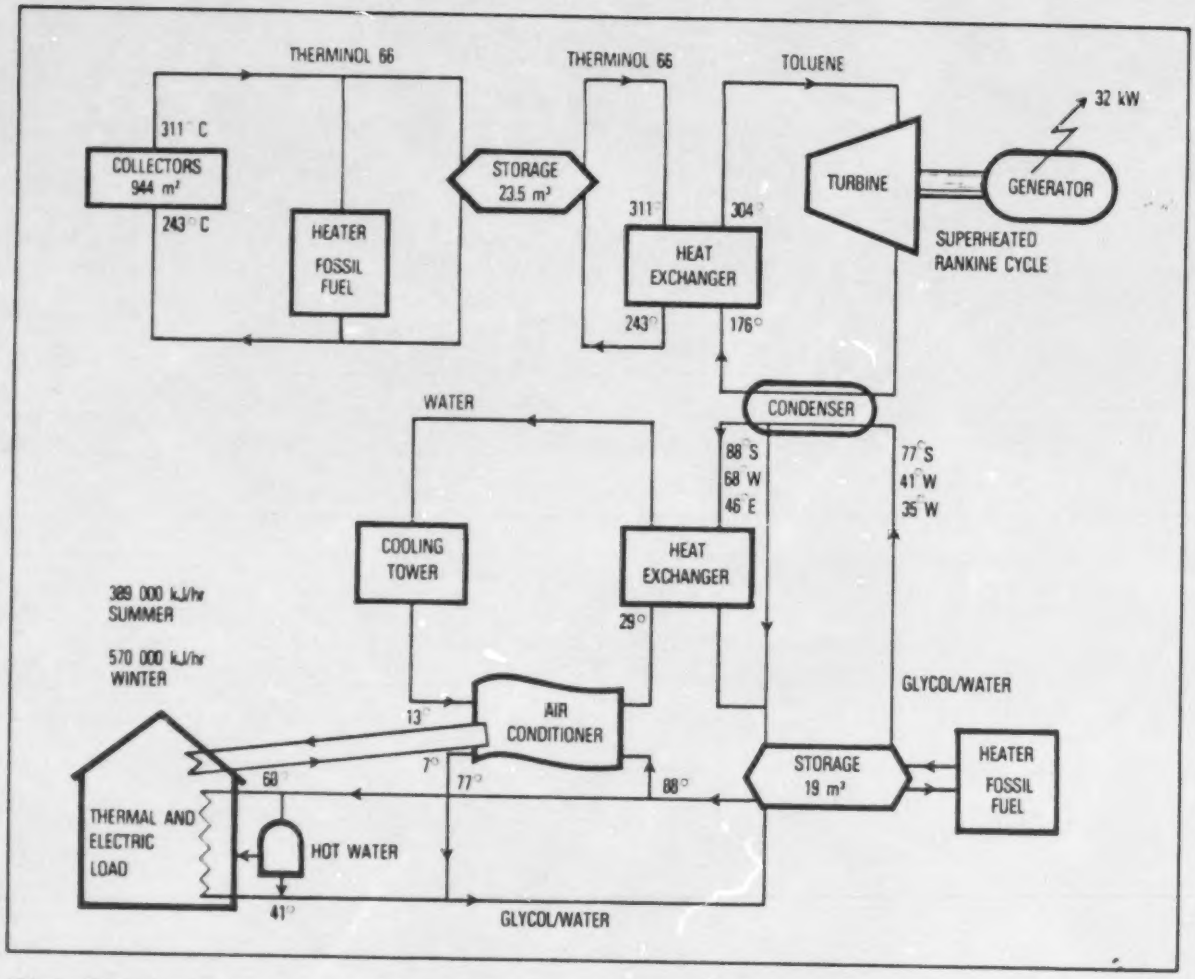
The MSSTF consists of a solar collector field, high-temperature thermal storage facilities, an electrical power generation subsystem, a lithium-bromide absorption air conditioner, an instrumentation and control system, and a cooling tower. The MSSTF can produce 32 kWe and about 200 kWth. As an exercise in operating system feasibility, this energy is supplied to a nearby 1100 $m^2$ (12,000 $ft^2$) office building. The component chosen for each segment of the MSSTF was selected to be evaluated on a long-term basis (1 yr or more) for potential incorporation into larger solar total energy or other dispersed solar power systems. Specifically, the test facility provides the capability for development tests of prototypes for Large-Scale Experiments and Demonstrations.

The accompanying schematic shows operation of the entire system. The collector field that powers the test system initially contains four different collector arrays, each providing about 25% of the solar power required for peak output of the system. Each collector system can operate independently or in conjunction with the other three arrays. The parabolic trough array, designed and built by Sandia,

(consistsof four 18.3-m-(60 ft)-long troughs with receiver tubes extending the full length of each trough. Sun tracking is controlled by a programmed minicomputer. A parabolic dish designed by Raytheon Inc., features two-axis tracking, which is also computer controlled. The fixed-mirror solar collectors designed by General Atomic Co. are fixed, precision-cast concrete troughs with silvered glass facts and feature a tracking receiver tube controlled by sun sensors. The Solar Linear Array Thermal System (SLATS) is a design by Suntec Systems, Inc., and features mirrored slats that track the sun and focus radiation on a fixed-receiver assembly. After completion of planned testing, current collector systems may be replaced with improved or alternate types.

The fluid-transfer system interconnects all facility subsystems. The fluid loops consist of valves, pumps, insulated pipelines, and flow sensors. The heat-transfer fluid is a high-boiling-point oil (Therminol-66), which remains liquid with low vapor pressure at system working temperatures of 315°C (600°F).

Two high-temperature storage systems permit collection and storage of the heated fluid at acceptable working temperatures. The first, a single tank stratified storage system, is insulated by an evacuated jacket filled with multifoil insulation. The top and bottom of the tank each has 60 cm (24 in.) of bulk insulation. The second system consists of three separately connected tanks with bulk insulation.




This simplified schematic shows operation of the Midtemperature Solar Systems Test Facility.

The toluene heat exchanger is the interface between the heat transfer fluid and the turbine working fluid. The toluene is heated to 308°C (588°F) at a pressure of 1.9 MPa (275 psi) and enters the turbine as super-heated high-pressure gas. The single-stage turbine is driven at 25,000 rpm by the toluene gas. The generator, with a peak electrical

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For information regarding the Solar Total Energy Test Facility and opportunities for collector testing, contact
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Midtemperature Solar Systems Test Facility Division 5712
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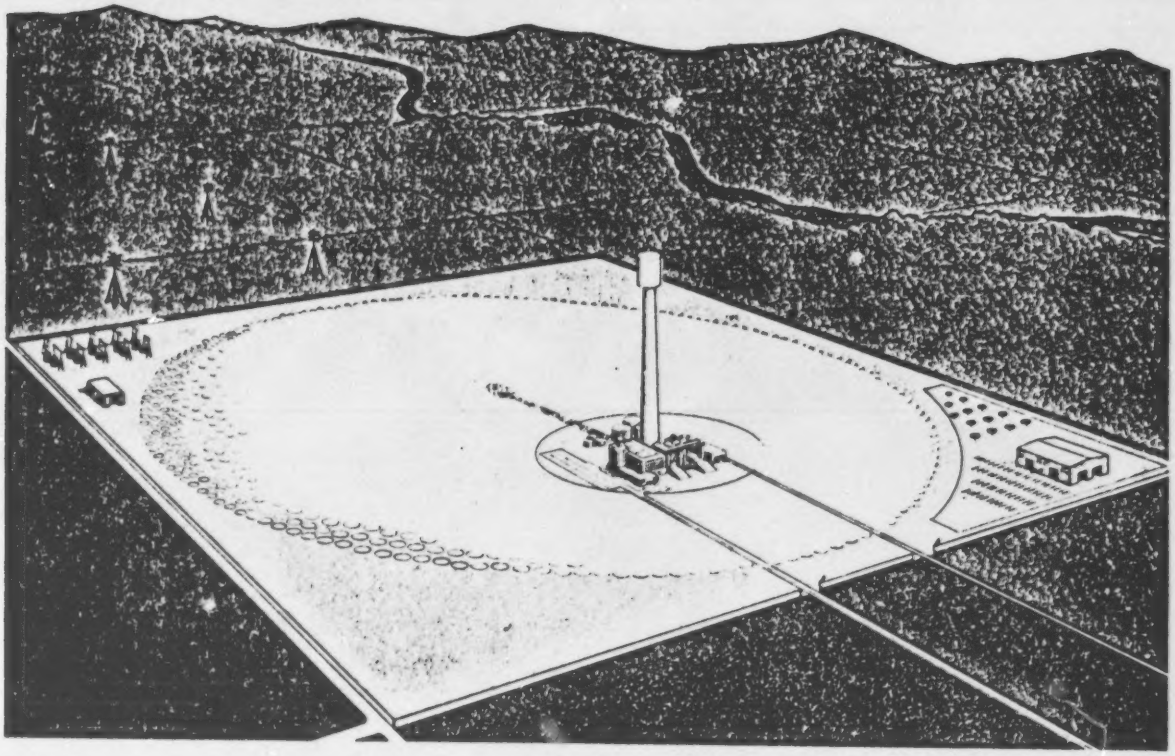
power rating of 32kW, is shaft-coupled to the turbine through a gear train. Turbine condenser coolant water is drawn off and pumped to low-temperature storage tanks. Two low-temperature storage tanks store heated condenser cooling water until needed for operation of heating or cooling components. An induction-spray, evaporative-cooling tower dissipates heat from the turbine, and the absorption air conditioner can be used to simulate loads for systems under evaluation.

# Central Receiver Solar Thermal Technical Program



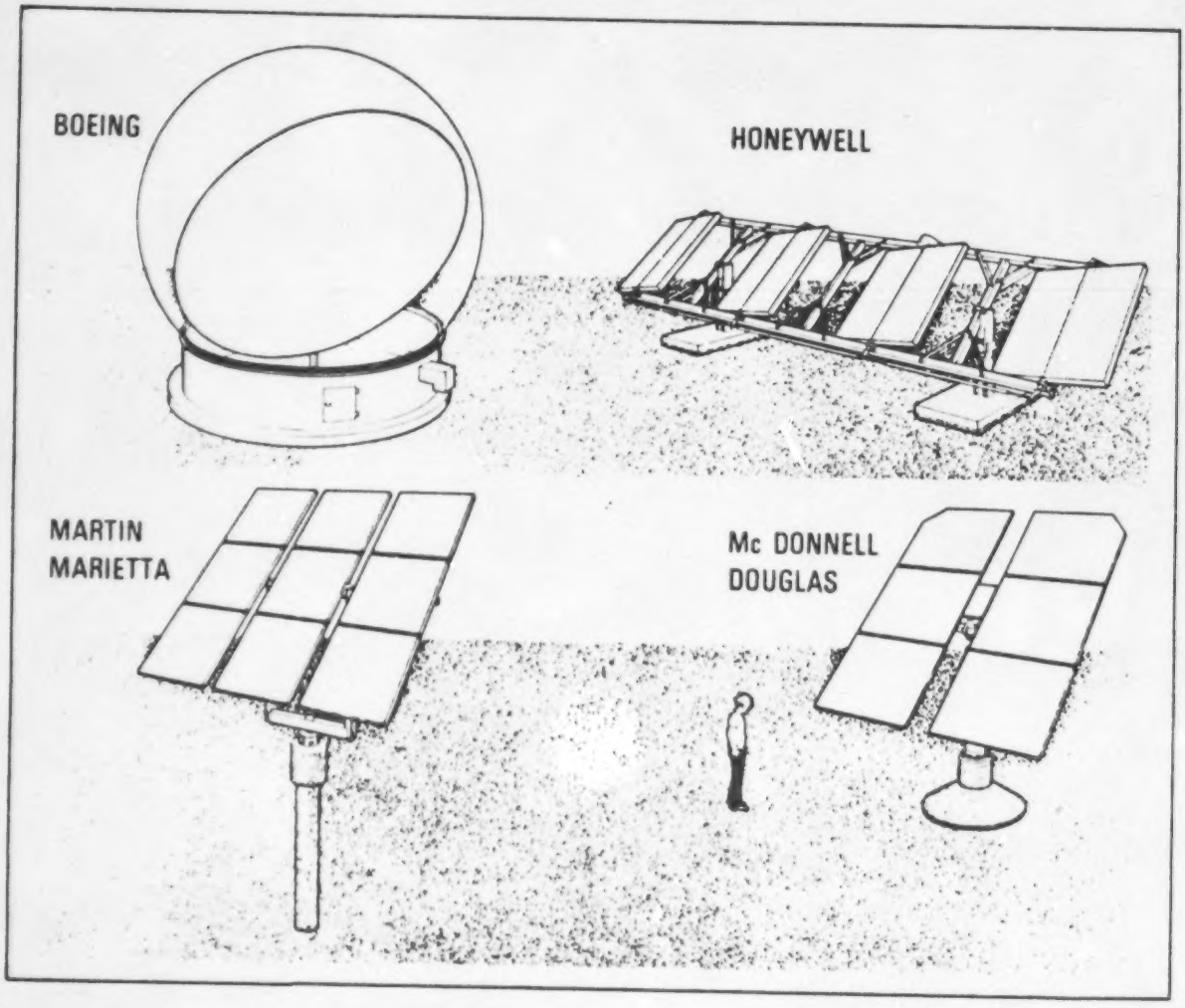
Artist's conception

Solar Thermal Electric Pilot Plant. In March 1977, DOE selected the site and participants for the first solar thermal electric pilot plant in this hemisphere, and the largest in the world. Located in the Mojave Desert near Barstow, CA, the plant is being built in cooperation with Southern California

Edison Co. It will produce 10 NWe, approximately the amount of power required by a city of 10,000.

As technical manager of the national Central Receiver Program, Sandia has the major responsibility for the conceptual design and technical direction of the pilot project as well for research directed at future systems. In 1972 Sandia initiated research that indicated the central receiver concept had merit. The basic idea is not complicated--tracking reflectors (heliostats) focus solar radiation onto a receiver

These are among the heliostat designs being considered for the Central Receiver Program



mounted high atop a tower. In the receiver, super-heated high-pressure steam is generated that either drives a turbine/generator to produce electricity or is directed to a thermal storage subsystem for use when solar insolation is not available.

While investigators believe no scientific breakthroughs are required, the program demands much in the way of new technology. Emphasis is being given to developing special materials, improving receiver and heliostat design, and optimizing thermal storage systems. A primary goal of the project is to develop low-cost components and subsystems that will enable the solar thermal power system to produce electricity on a competitive basis with the more conventional power-generating systems.

One of the top riorities of the Central Receiver Program is to seek active participation by industry, elements of local government, and other interested groups. Accordingly, the first pilot plant will be operated by a team of utility companies headed by Southern California Edison, with participation by Los Angeles Department of Water and Power and the California Energy Resources, Conservation, and Development Commission. Proposed solar components and systems were conceptually designed by contract teams headed by Boeing Engineering and Construction Co., Honeywell, Inc., Martin-Marietta Aerospace, and McDonnell Douglas Astronautics Co. The McDonnell Douglas design was selected at the conclusion of the conceptual design phase.

Even as work proceeds on the first pilot plant, a second-generation advanced-technology solar central receiver power plant has entered the planning stage. It will incorporate the best features of the first unit while untilizing liquid sodium, molten salt, helium, or air as the heat-transfer fluid. Work is proceeding on these concepts by teams headed by Boeing Engineering and Construction Co., General Electric, Martin-Marietta, and the Atomics International Division of Rockwell International.

The 10-year schedule for the Central Receiver Program established by Sandia and DOE calls for the design and contruction of a solar thermal plant in the 50 to 300 MW size range by the mid-1980s.

Solar Thermal Test Facility. The 5MW Solar Thermal Test Facility (STTF) located southeast of Albuquerque, NM, was built to support the Central Receiver Solar Thermal Test Program. The first series of experiments are concerned with the receivers and heliostats proposed for the 10-MW pilot plant project in Barstow, CA.

Future experiments include work on advanced central receiver designs, Electric Power Research Institute's (EPRI) receiver models, high-intensity photovoltaic devices, heliostat designs, and material/chemical properties and processes. The STTF consists of 222 focusable, individually controlled heliostats, each having $37m^2$ of reflective surface. These heliostats, which are computer-controlled, collect and concentrate $>5$ MW thermal solar power with a peak flux level

to ~10 $MW/m^2$ over a 0.1-$m^2$ area. Experienced engineering personnel are available at the STTF to assist experimenters in meeting specific test requirements. Flexibility has been designed into the STTF specifically to deal effectively with all experimenters. The heliostats can be positioned north of the test tower or in a circular array around the tower. The 60-m test tower has test bays at the top; north-facing, at heights of 48, 42, and 36 m; test bays; and knockout panels facing east and west at 36- and 48-m heights. All test bays are served by a 90,000-kg elevator, 500 data acquisition channels, and provision for connection to the heat-rejection system.

DOE's long-range goal for the STTF is to use it as a national experimental resource to develop solar thermal electric power, and to explore technology for other solar energy conversion processes. The facility will serve government agencies, research institutes, universities, and industry. An STTF Users Association has been established to assure maximum effective use by researchers throughout the country. Interested parties are encouraged to contact STTF management or the STTF Users Association concerning use of the facility, experimental capabilities, and current status.

# Photovoltaic Systems Definition Project

System Engineering and Analysis. Photovoltaics, the direct conversion of solar radiation to electricity, is one of the newest technologies for tapping the sun's power. A product of modern semiconductor research, photovoltaic systems have provided an on-board power source for hundreds of spacecraft. Photovoltaics are now under intensive study as a promising method for major terrestrial electric power generation.

The national Photovoltaic Conversion Program is dedicated to the development of reliable, low-cost power systems and to the creation of technical and industrial capability to manufacture and distribute those systems. Sandia has a leading role in the national program as DOE's manager of the Systems Definition Project. This effort is directed to systems engineering and analysis and to developing arrays that use optical concentrators to enhance performance and lower the effective cost of photovoltaic power systems. Most of the technical work is performed by private industry and educational institutions under contract

The objectives of the System Engineering and Analysis task are to identify promising applications and configurations for power generation systems, and to establish component and subsystem requirements within practical economic and technical limits. Project investigators take a number of paths to attain these objectives, including

- Performing systems analyses and design studies to identify applications and configurations that merit further development
- Assembling information on design performance, economics, legal factors, institutional considerations, and environmental impacts of photovoltaic applications
- Providing system engineering support to experiment and demonstration projects in the Photovoltaic Program
- Developing and evaluating components and subsystems for operational power systems

Photovoltaic Concentrator Systems. Another major part of Sandia's project effort is to develop solar arrays that concentrate sunlight onto solar cells as a way to reduce the overall cost of photovoltaic power systems. The intent of this work is to replace expensive solar-cell area with less-expensive concentrator area.

Solar cells in concentrator arrays operate at high solar illumination with resulting increases in output power and operating temperature. Cells under investigation include those made from silicon, gallium arsenide, and other compound semiconductor materials. The process of evaluating a wide range of concepts has led to the design and construction of several advanced photovoltaic concentrator arrays.

One such array under evaluation simultaneously generates 1 kWe and 5 kWth.

The array uses 135 silicon solar cells, each 5 cm in diameter and capable of generating 7.4 W of power in concentrated sunlight. The optical concentrator is an array of molded plastic Fresnel lenses mounted in a framework a fixed distance from the solar cells. The lenses intensify solar radiation on the cell surface 50 times, which in turn increases cell performance, is removed by mounting the cells on collector tubing through which water can be circulated. Water heated by the array can then be used for heating, absorptive air conditioning, and domestic or process hot water. Passive cooling by the ambient air is also possible.

Sandia scientists believe that the concentrator approach may eventually help make photovoltaic systems competitive with conventional power-generating methods. The near-term goal is to reduce array price to $2000 or less per peak kilowatt by 1980.

# Vertical-Axis Wind Turbine

About 50 years ago, a French inventor, D.J.M. Darrieus, designed an unusual vertical-axis wind turbine (VAWT) using modern aerodynamic principles. For nearly 45 years the turbine drew little attention. Recent research into utilization of renewable energy resources has revived interest in the concept as a possible candidate for a practical wind power system.

Sponsored by DOE's Wind Energy Branch, Sandia is exploring the capabilities of the VAWT as an alternative energy source. Computer modeling and analysis, along with design and actual operation of prototype turbines, will seek to establish mechanically practical machines suitable for industrial applications. Other research is aimed at defining potential applications, economics, and best geographic locations for VAWT power systems.

The VAWT has several potential advantages over conventional horizontal-axis wind turbines that possibly result in lower costs. For instance, the VAWT needs no yaw control to bring it into the wind nor pitch control for operation in high winds; the vertical orientation of the turbine

allows the transmission and generator to be mounted at ground level; and finally, its overall weight is substantially less than for comparable conventional systems. Disadvantages include lower aerodynamic efficiency; and it will not start by itself.

Sandia has constructed two VAWTs for development and testing. The first unit, constructed in 1974, is 5 m in diameter and produces peak electrical output of ~5 kW. A second turbine, 17 m in diameter, was erected in early 1977 and is rated at 60 kW. The 17-m turbine is shown in the accompanying photo. Both machines remain in use today for aerodynamic performance and structural vibration testing.

The future thrust of the VWAT project will emphasize transferring technology developed in the design and testing of these experimental systems to the commercial sector. This will be accomplished through joint programs between Sandia and private industry to design and develop a series of commercially suitable, low-cost turbine systems. This effort will attempt to resolve and optimize the often conflicting requirements of low cost, manufacturability, and technical requirements. Studies are now under way to define the range of sizes and configurations that this optimized turbine series should include, as well as an assessment of ultimate costs. More will then be known about the status of the VAWT as a viable energy alternative.

# Solar Irrigation

An experimental solar-powered irrigation system was operated during the 1977 growing season in New Mexico, with a second larger system now under design to be located in Arizona. These projects have been established to explore the practicability of solar irrigation systems in the Southwest.

There are more than 160,000 irrigation wells in Arizona, California, New Mexico, and Texas powered by natural gas, with thousands of additional pumps powered by diesel engines or electricity. With ever-increasing fuel costs and potential shortages, many of these wells could become unprofitable to operate. Solar-powered irrigation, if proved technically and economically sound, will provide a clean alternate source of energy for irrigation.

New Mexico Project. The New Mexico solar irrigation project is a joint effort of DOE and the State of New Mexico. Technical management and system engineering are directed by Sandia, and agricultural experiments by New Mexico State University.

Generally, the system consists of a solar collector field, thermal storage tank, solar engine, irrigation pump, water

storage pond, and the system instrumentation and controls, all located on less than 4 acres. The solar engine, an organic Rankine-cycle turbine, supplies 25 shaft horsepower to the irrigation pump. The pump delivers 2600L/min of water from 30-m-deep well. The plastic-lined pond stores 4.5 acre-ft of water. When the system is not operating the irrigation pump, it can generate 10 million k /day of heat, or 20 kWe for other farm uses including space heating, crop drying, and farrowing and poultry houses.

The experiment was dedicated July 8, 1977. Operational data are presently being collected and evaluated. This information is expected to aid in the design and operation of the next solar irrigation experiment.

Arizona Project. DOE in a joint venture with the State of Arizona is conducting a deep-well solar irrigation experiment near the town of Coolidge, AZ. DOE has overall project and contractual management; Sandia is responsible for technical management; the State of Arizona shares the funding and is in charge of site selection; and the University of Arizona will conduct the agricultural experiments.

The project was divided into two phases--design study, and construction. During the design study phase, industrial contractor teams assessed potential design options and weighed the advantages of each approach.

Design studies were completed in September 1977, and a team headed by Acurex Corporation was awarded the construction

contract. Construction is scheduled for completion in January 1979. Sandia will be working with Acurex to transfer the technology gained from the New Mexico experiment. Progress reports will be made regularly on the experiment to keep industry informed on technology improvements.

# Solar Support Projects

Solar Monitoring Station. The Solar Monitoring System is a compact portable system designed to operate reliably for long periods of time with minimum maintenance. Data are collected on total and direct insolation temperature, wind velocity and direction, and other climatic variables. Systems have been built and are in operation at U.S. solar experiment sites. Sandia will furnish an updated version of the Sandia Solar Monitor System to the DOE's Division of Solar Technology for use by the International Energy Agency (IEA) as an aid to solar site selection. This station requires addition of sensors and modification of instrument fixtures to make the power system compatible with IEA requirements.

Standard Meteorological Year Derivation. The two main objectives of the Standard Meteorolcgical Year Derivation are to utilize statistical methods to

> Develop a method for generating a standard year with respect to the six meteorological variables that include direct normal and total horizontal radiation; wind direction and velocity; temperature and relative humidity, and
>
> Generate a standard year and compare it with available meteorological data

Solar Heating and Cooling (SHAC) Technical Support. The objective of this is to furnish the Research and Development (R&D) Branch of the DOE's Division of Solar Technology with

system analysis support. This support will help the R&D Branch evaluate and direct activities that will result from implementation of the R&D Program. The SHAC support function includes the following tasks:

In-House Research

Program Planning

Project Evaluation

Proposal Review

System & Economic Analysis and Inter-laboratory Coordination

Procurement Activities

Solar Heating and Cooling (SHAC) Waste-Disposal Impact. The objective of this program is to examine flammability, toxicity, and environmental persistence of candidate fluids, which will lead to recommendations for methods of treatment, packaging, interim storage, transportation, disposal, or reclamation.

Solar Technology Transfer -- Southwest. The purpose of the Sandia Laboratories Technology Transfer Project is to augment the technical projects and speed up the generation of an industry related to the DOE Solar Energy Program. There are three major objectives:

(1) to take the initiative in identifying the organizations and persons best able to accelerate commercial development

(2) to supply selected technology in the forms best suited to rapid transfer of a commercial capability, with emphasis on early impact technology and a continuing program to help accelerate the longer term options

(3) to feed back information to the Division of Solar Technology program management of suggested changes in program emphasis, based on needs identified in the outreach efforts

SOLAR ENERGY TECHNICAL REPORT

EXHIBIT A

EXHIBIT A

## CENTRAL SOLAR RECEIVER

A two-year effort to develop the necessary technology for design and construction of a central solar receiver power plant was recently completed. We provided technical management of this program, which represents a major milestone in the collection and use of solar energy to produce electricity on a commercial scale.

Four contract teams--consisting of groups from Honeywell, Martin Marietta, McDonnell Douglas, and Boeing--carried out conceptual system design and component development work. We have evaluated the resulting technologies and selected the most promising configuration, which was chosen by DOE for use in the first 10-MWe central solar receiver pilot plant. The concept, developed by a McDonnell Douglas team, includes a collector array of 2300 glass mirrors that covers about 100 acres of land, a cylindrical "external" boiler sitting atop a 96-metre receiver tower, and an oil/rock thermal energy storage system to provide about 5 hours' operation at 7 MWe.

The pilot plant will provide economic and operating data to help assess the commercial potential of central solar receiver power plants. It will be located in the Mojave Desert near Barstow, California, with start of construction

scheduled for early 1978. A team of utility companies headed by Southern California Edison is providing the site and the turbine generator subsystem, and will operate the facility.

## Design Concept

The concept for a central solar receiver power plant, illustrated in Figures 1 and 2, consists of a field of individually controlled mirrors, or heliostats, that direct solar energy to a receiver mounted on top of a tower. In the receiver the highly concentrated solar flux heats a circulating fluid that is then used to power a conventional steam turbine generator. Alternatively, the collected energy can be stored for later use.

Commitment at this time to the central solar receiver concept for power generation is based on several factors.

Feasibility: Large-scale demonstration within 10 years looks feasible from an engineering point of view. For instance, existing technology in the power generation field, such as turbine and steam generator systems, can be utilized.

Concentrations: Tracking heliostats can produce relatively high concentrations of solar flux (1000 suns or greater), thus minimizing radiation and convection losses. This provides high receiver efficiency at high temperatures (500° C) and reduces the required heliostat area.

Economics: While it is difficult to make accurate projections of the economics of developing technologies, commercial-scale central receiver power plants will be potentially cost effective if the DOE goal of $1300 per kilowatt can be met. This will require substantial reductions in the costs of heliostats and energy storage subsystems.

Figure 1. Operational schematic for a solar central receiver power generation system. Solar energy is converted to steam in the receiver and used to operate a conventional turbine/generator system. Thermal storage is provided to smooth out operating transients.

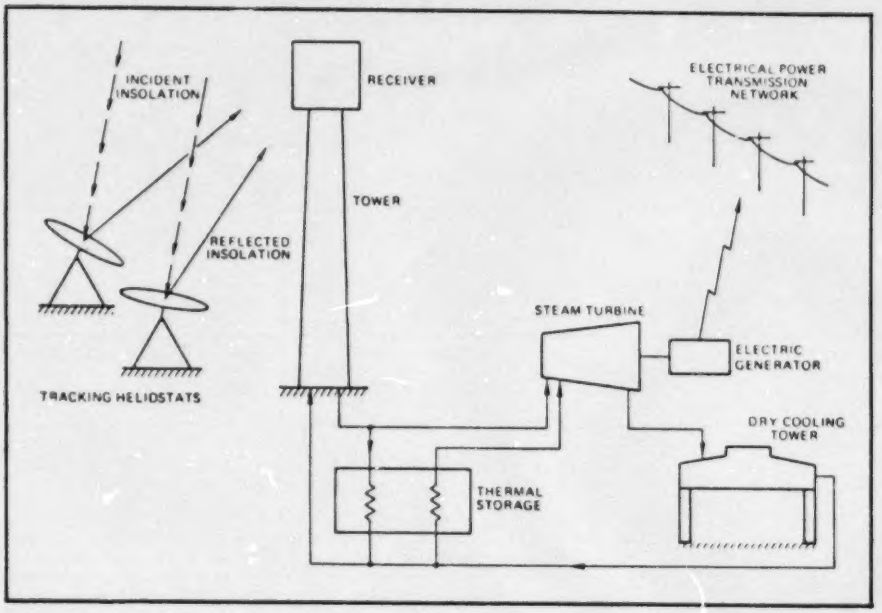
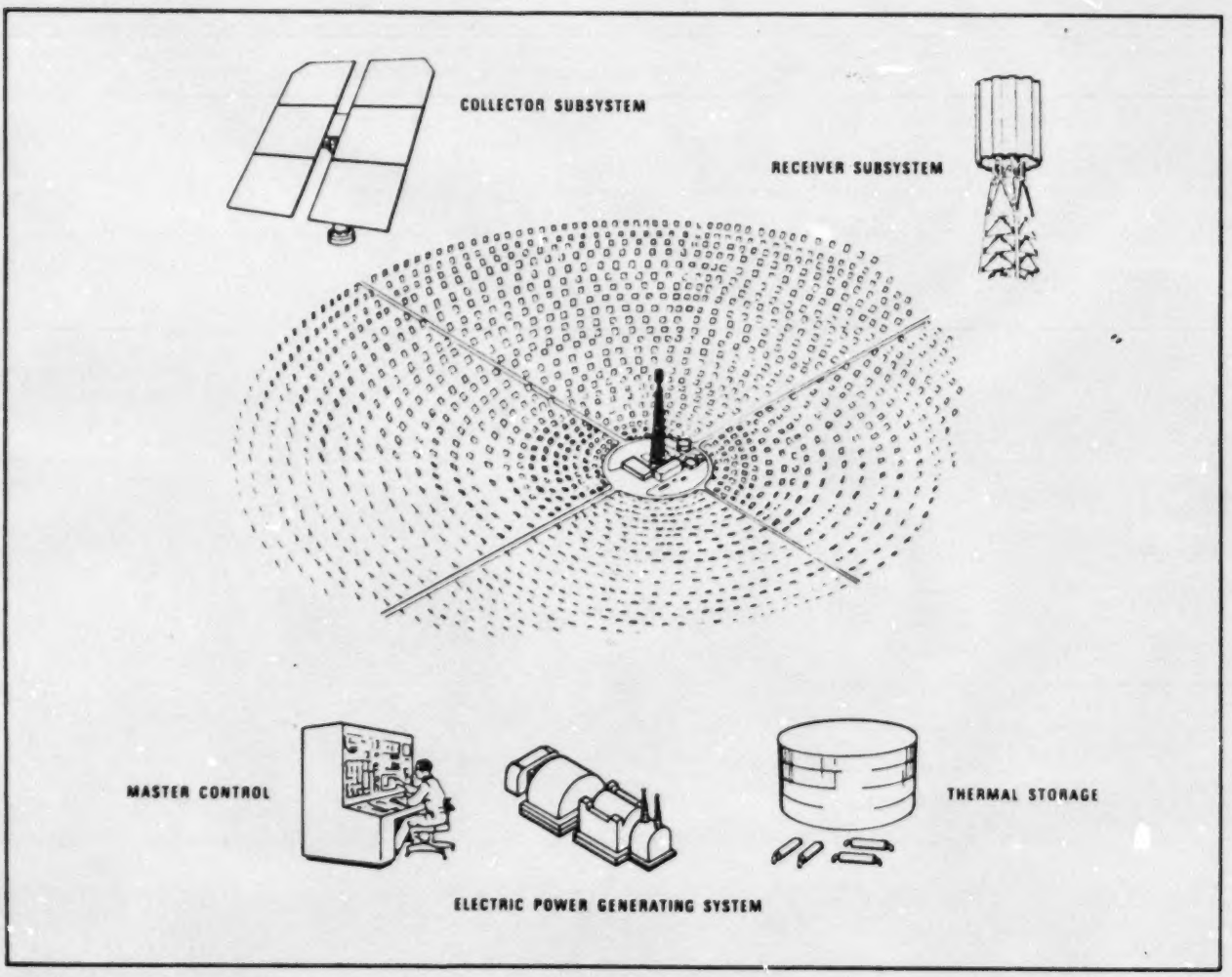



Figure 2. Artist's concept of a 10 MWe central solar receiver pilot plant. Sun-tracking heliostats, covering about 100 acres of land, direct solar energy to the 100-metre receiver tower. Energy storage and electrical generating equipment are located near the base of the receiver tower.



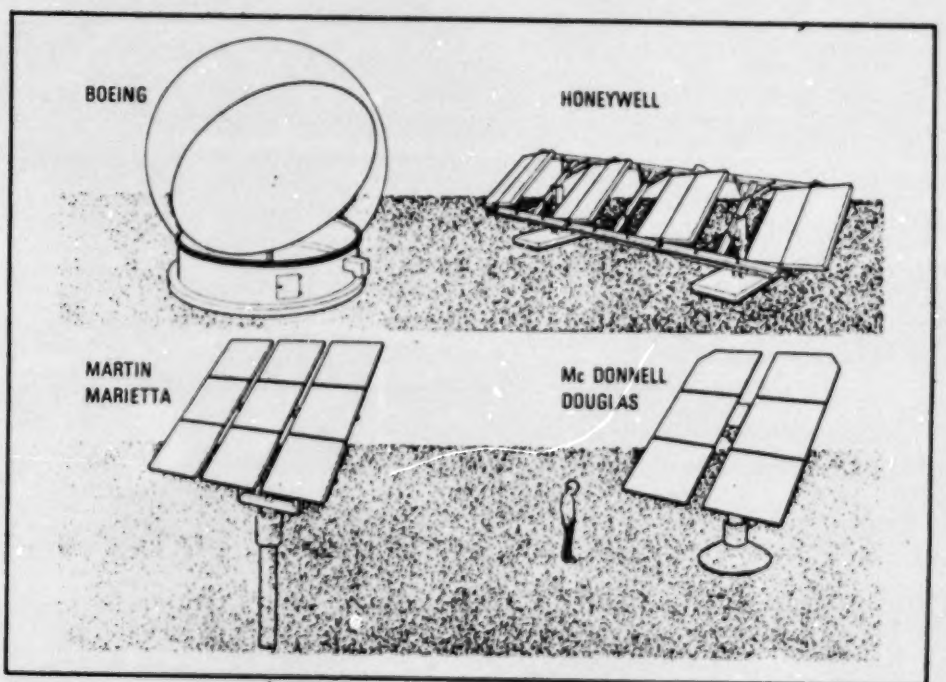
Subsystem Design and Development Considerations

The central solar receiver concept required no fundamental technological breakthroughs; however, considerable engineering development will be necessary to obtain a cost-effective design. Major elements of the system requiring development are the heliostats, the receiver, and the energy storage system.

Heliostats -- Critical design requirements for the heliostats included: accurate orientation of the mirror surfaces in winds to 13 m/sec (30 mph); survival in winds to 40 m/sec (90 mph); high surface reflectivity, long lifetime, and minimum maintenance.

Four different heliostat configurations, each with about 40 $m^2$ of reflective surface (Figure 3), were evaluated. Three

Figure 3. Pilot plant heliostat design concepts for the 10-MWe Central Solar Receiver pilot plant. A transparent air-supported dome is used in the Boeing design to protect the mirror from adverse weather. The other three designs rotate the mirrors to an inverted position.



configurations are based on conventional designs that use steel frame construction and glass mirrors. Environmental protection of the reflective surfaces is provided by second-surface mirrors and by storing the mirrors in an inverted position. The fourth heliostat design uses a lightweight aluminized polyester film mirror and a transparent air-supported plastic dome to protect the heliostat structure from adverse environments. Aiming of the mirrors is accomplished either with a preprogrammed, computer-controlled algorithm or by using active reflected-beam sensors to control drive motors.

Receiver -- Mounted on top of a tower and located in the midst of the heliostat field is the receiver, which accepts concentrated solar energy from the heliostats. Two design types were evaluated (Figure 4). In the first, energy is absorbed on the surfaces of coolant tubes that line the inner walls of a cavity. Separate boiler and superheater sections are connected through an intermediate steam drum. The second design features an external boiler consisting of panels of vertical tubes in which the boiling and superheating processes occur in a single pass.

Both receiver concepts are designed to use water/steam as the circulating coolant because a minimum of development is required for this existing commercial technology. Receiver efficiencies* vary from 84% to 94%.

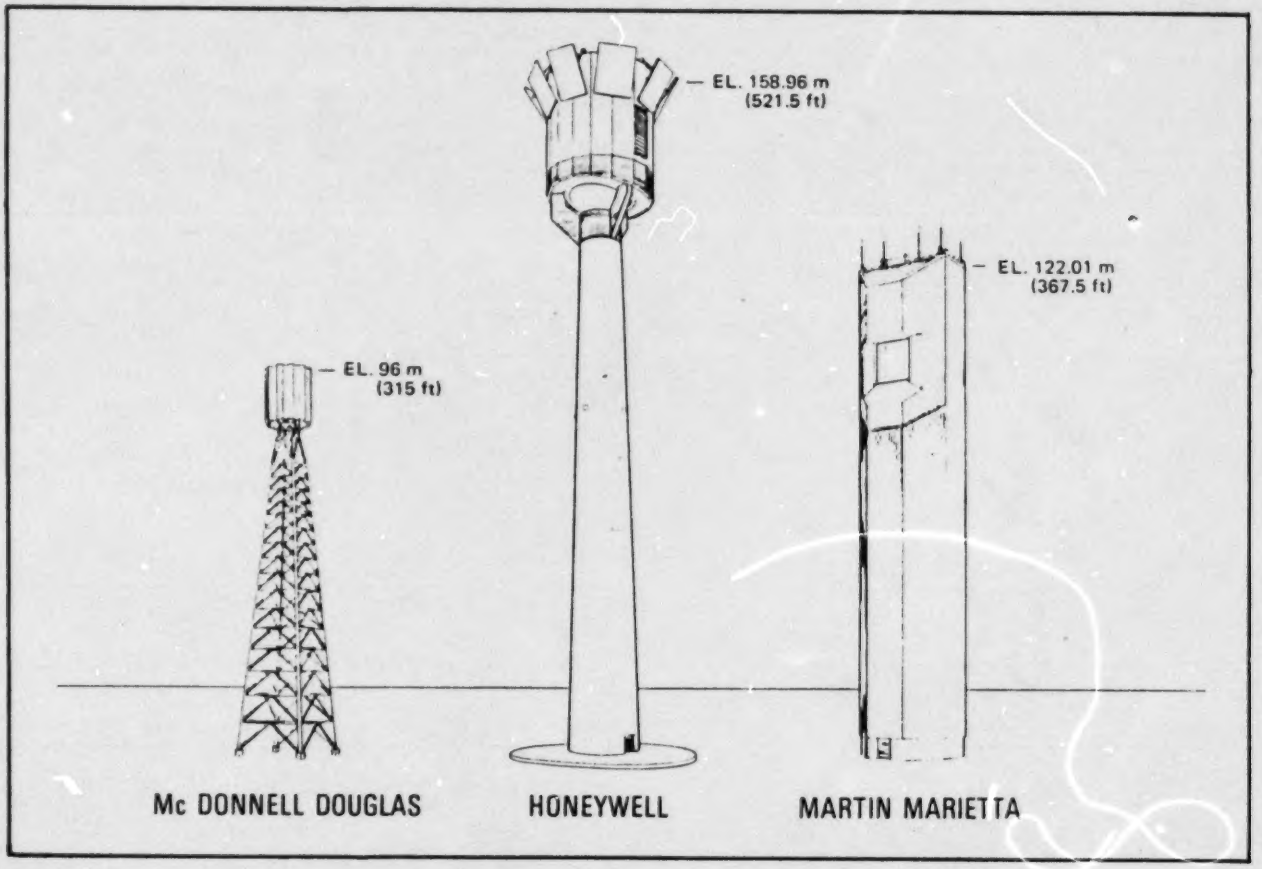
Energy Storage -- As with all intermittent energy generation techniques, some storage is desirable for power production

*Defined as the ratio of energy transferred to the working fluid in the receiver to energy incident on the receiver.

during periods of no insolation (nighttime) or in combination with the receiver subsystem during periods of low insolation (cloudy days). The thermal storage subsystem, located near the base of the receiver, removes the energy through heat exchangers, and stores it for later use.

Both sensible heat and change-of-phase storage concepts were evaluated. Acceptable storage media were found to be heat-transfer-oil, both with and without rocks immersed in the oil, for low-temperature storage, and molten salt for high-temperature storage. Energy densities achieved in the

Figure 4. Pilot Plant Receiver Concepts. In the McDonnell Douglas design, energy is absorbed externally on the vertical panels in which coolant tubes are imbedded. In the last two designs, energy is absorbed on surfaces of coolant tubes that line the inner walls of the cavity. All three designs use water/steam as the circulating fluid.



storage materials varied from 44 J/g in the rock to 324 J/g in molten salt.

Operational Time Frame

Subsystem design and experiments have been completed, and the pilot plant is expected to be operational during 1981. Power generated from the pilot plant will be supplied to the Southern California Edison electrical network. Operating and economic data will be obtained for a plant of the 10-MWe size and, by scaling, for future commercial-sized plants in the 50- to 200-MWe range.

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Technical report by A. C. Skinrood.

SOLAR ENERGY RESEARCH

Vocabulary

Aeorodynamic: A branch of dynamics that deals with the motion of air and other gaseous fluids and with the forces acting on bodies in motion relative to such fluids.

Algorithm: A step-by-step procedure for solving a problem or accomplishing some end.

Ambient air: Surrounding on all sides: ENCOMPASSING.

Aperture: The diameter of the stop in an optical system that determines the diameter of the bundle of rays traversing the instrument.

Arrays: An arrangement of computer memory elements (as magnetic cores) in a single plane.

Component: Serving or helping to constitute.

Conceptual: An abstract or generic idea generalized from particular instances.

Cylindrical: Relating to or having the form or properties of a cylinder.

Dynamics: A branch of mechanics that deals with forces and their relation primarily to the motion but sometimes also to the equilibrium of bodies.

Electrolyte: (water) A substance that when dissolved in a suitable solvent or when fused becomes an ionic conductor.

Facets: The external corneal surface of an ommatidium.

Heliostat: An instrument consisting of a mirror mounted on an axis moved by clockwork by which a sunbeam is steadily reflected in one direction.

Illumination: To supply or brighten with light; to subject to radiation.

Insolation: To expose to the sun's rays.

Kilowatts Electrical; kWe, abbr: 1000 watts of electrical energy.

Low insolation: (Cloudy day) Below the normal exposure to the sun's rays.

Megawatts thermal; MWth, abbr: 1,000,000 watts of heat.

Meteorological: A science that deals with the atmosphere and its phenomena and esp. with weather and weather forecasting.

No Insolation: (Nighttime) No exposure to the sun's rays.

Optical: Of, relating to, or utilizing light.

Parabolic: A plane curve generated by a point moving so that its distance from a fixed point is equal to its distance from a fixed line: the intersection of a right circular cone with a plane parallel to an element of the cone.

Petrochemical: A chemical isolated or derived from petroleum or natural gas.

Photoelectrolysis: To develop an economic method of producing hydrogen using a solar-illuminated semiconductor system.

Photovoltaic: Of, relating to, or utilizing the generation of an electromotive force when radiant energy falls on the boundary between dissimilar substances.

Prototype: An original model on which something is patterned.

Receiver: The portion of a telegraphic or telephonic apparatus that converts the electric current or waves into visible or audible signals.

Reflectivity: Capable of reflecting light, images, or sound waves.

Semiconductor: Any of a class of solids (as germanium or silicon) whose electrical conductivity is between that of a conductor and that of an insulator in being nearly metallic at high temperatures and nearly absent at low temperatures.

Sensor: A device that responds to a physical stimulus (as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control).

Solar: Of, derived from, or relating to the sun esp. as affecting the earth.

Solar radiation: The combined processes of emission, transmission, and absorption of radiant energy from the sun.

Stratified: To form, deposit, or arrange in a bed or layer artificially made.

Subsystem: A secondary or subordinate system.

Sun Sensors: (See Sensor)

Terrestrial: Of or relating to the earth or its inhabitants.

Thermal: Of, relating to, or caused by heat.

Thermodynamic: Physics that deals with the mechanical action or relations of heat.

Toluene: A liquid aromatic hydrocarbon $C_7H_8$ that resembles benzene but is less volatile, flammable, and toxic, if produced commercially from light oils from coke-oven gas and coal tar and from petroleum, and is used as a solvent, in organic synthesis, and as an anti-knock agent for gasoline.

Turbine: A rotary engine actuated by the reaction or impulse or both of a current of fluid (as water or steam) subject to pressure and usu. made with a series of curved vanes on a central rotating spindle.

Turbine generator: A machine by which mechanical energy is changed into electrical energy by a turbine.

Velocity: Time rate of linear motion in a given direction.

Viable: Capable of existence and development as an independent unit.

# MINING INDUSTRY

## MINING INDUSTRY

So that you may have some insight into the industry in general, the following pages will give you general information about potash, copper, and uranium mining.

## POTASH MINING

Mining methods used by the industry in the Carlsbad district are principally of the room and pillar type. The relatively flat-lying potash beds are particularly suitable for this method. Recently, experimental long-wall mining has been tried with the use of continuous mining machines. Extraction rates in the conventional room and pillar method are in excess of 90 percent upon completion of the second mining or pillar removal phase. The mines are highly mechanized and use heavy duty equipment similar to that employed in underground coal mining. The U.S. Borax & Chemical Corp. employs the chemical refining process whereby crude ore is crushed and the sylvite dissolved in a potassium-deficient sodium chloride brine; from this solution the potassium chloride is reprecipitated by carefully controlling temperature and pressure. This company has also employed a gravity separation system, using tabling methods to upgrade the ore.

Methods of mechanical separation were studied by private firms and by the U.S. Bureau of Mines. Research and

study demonstrated that the methods of froth flotation could be applied to potash ores to separate sylvite from the gangue minerals, which consist principally of halite. As a result all companies except U.S. Borax & Chemical Corp. use the flotation method of refining sylvite ores. Crystallizing equipment is also used in conjunction with flotation to improve recovery of fine minerals.

The refining of langbeinite ores is relatively simple. Fresh water is used to dissolve the gangue minerals, again principally halite, leaving the less soluble langbeinite products undissolved. In recent years selective flotation methods have been developed by International Minerals & Chemical Corp. which will allow it to recover both sylvite and langbeinite from mixed ores.

## COPPER

The copper mines operated by Kennecott Copper near Silver City, New Mexico is an open-pit mine. Open-pit mining methods are applicable to mining disseminated ore deposits that apex at or near the surface. If the apex is below the surface, then the barren capping (overburden) overlying the ore body must be removed. The usual pit, when fully opened up, resembles an immense amphitheater having one end open for entry and egress of ore trains.

Blast holes are drilled by churn drills in rows back from and parallel to the bench faces. They are loaded with explosives, and as many as 40 to 50 holes are blasted

simultaneously, loosening and shattering as much as 250,000 tons of ore. The broken ore is picked up by power shovels and loaded into trains of cars hauled on tracks, along the benches. This is the cheapest form of mining and is used for about 80 per cent of the copper ore mined in the United States. Ores containing only 0.50 per cent copper are being mined economically by this method.

## URANIUM

The output from New Mexico has been of vital importance to the Nation as well as to the State. In the 1957-63 period uranium production in New Mexico was 40 percent of the total for the country. The dollar values of the uranium ores mined have ranged from about 4 and 3 percent of the State's total mineral output, in 1956 and 1957, respectively, up to more than 9 percent in 1960 and 1962. Although there has been a general decline in output since 1960, New Mexico will probably continue to hold the same general proportion of total U.S. output for at least the next few years. The recent decline has resulted primarily from the saturated uranium market. Fringe benefits have been permitted to lapse, restrictions have been imposed on mine allotments, and the price paid for mill concentrates has been reduced. The bonus paid for initial production of uranium ores from new mines terminated February 28, 1957, and payments made for contained $V_2O_5$ were discontinued on ores that were too low in vanadium

for efficient vanadium recovery. In 1962, a stretchout program for domestic uranium procurement for the period from January 1, 1967, to December 31, 1970, was announced. It provides for deferring delivery to 1967 and 1968 of some uranium concentrates which were originally contracted for delivery before 1967, and for purchase of an additional amount of concentrates in 1969 and 1970 equal to the amount deferred to 1967 and 1968. In 1969 and 1970 the maximum price wa $6.70 per pound of contained $U_3O_8$. This general cutback resulted in the closing in 1963 of one uranium mill in New Mexico, leaving four operating mills and one on standby status in 1964. The combined rated capacity of these mills is about 10,000 to 11,000 tons of ore per day.

Uranium deposits in New Mexico occur in rocks of many ages and lithologic types. Two general types of deposits, peneconcordant and vein, occur in New Mexico. The most abundant, largest, and most productive are the peneconcordant deposits. These occur in sedimentary rocks and are nearly concordant (parallel) to the bedding. The deposits are found most often in thick fluvial sandstone and conglomeratic sandstone which has been bleached gray or stained brown. Such deposits have been referred to as sandstone-type deposits. To a lesser extent, peneconcordant deposits occur in lignite and carbonaceous shale, and in limestone. The deposits are roughly tabular to lenslike, tending to elongate and parallel, or nearly so, to such sedimentary features as sandstone lenses

and bedding structure. Most of the deposits are restricted to certain favorable stratigraphic units, where they occur in clusters, and these clusters in turn tend to occur in belts. The recognition of these features is useful in exploration for hidden deposits and in making resource appraisals. Size of the deposits ranges from local masses that contain less than a ton of material to large masses that contain as much as several million tons. The grade ranges from trace amounts to several percent uranium but the average grade of the ore is about 0.25 percent $U_3O_8$.

MINING INDUSTRY

Vocabulary

Amphitheater: a flat or gently sloping area surrounded by abrupt slopes.

Apex: the upper most point.

Bench: a former wave-cut shore of a sea or lake or flood-plain of a river.

Brine: water that has a large quantity of salt, especially sodium chloride, dissolved in it; salt water.

Carbonanceous shale: relating to, containing, or composed of carbon.

Egress: to go out.

Elongate: to extend the length of.

Flotation: the separation of the particles of a mass of pulverized ore according to their relative capacity for floating on a given liquid.

Fluvial: produced by stream action.

Froth: bubbles formed in or on a liquid.

Gangue: the worthless rock or vein matter in which valuable metals or minerals occur.

Gravity: the gravitational attraction exerted by the earth; the weight of a body.

Lithology: the study of rocks, usually the macroscopic study thereof. Also, the term is used to express the individual character of rocks in terms of mineral composition, structure, etc.

Pillar type: a solid mass of coal, rock, or ore left standing to support a mine roof.

Procurement: to take possession of.

Refine: to reduce to a pure state.

Reprecipitated: a substance separated from a solution or suspension by chemical or physical change usu. as a insoluble amorphous or crystalline solid.

Sedimentary rock: a rock composed of materials that were transported to their present position by wind or water. Sandstone, shale, and limestone are sedimentary rocks.

Separate: to isolate from a mixture.

Soluble: capable of being emulsified.

Sylvite: a mineral KCl that is a natural potassium chloride and occurs in colorless cubes or crystalline masses.

Vanadium: a grayish malleable ductile polyvalent metallic element found combined in metals and used esp. to form alloys (as vanadium steel).

## REFERENCES


A Dictionary of Petroleum Terms. Petroleum Extension Service, Texas Education Agency. Austin: 1976.

Mineral and Water resources of New Mexico. United States Geological Survey. Washington, D.C.: U.S. Government Printing Office, 1965.

Sandia Technology. Sandia Laboratories. Washington, D.C.: U.S. Government Printing Office, Unlimited Release, Vol 3, No. 3, September 1977.

Solar at Sandia Laboratories. Sandia Laboratories. U.S. Department of Energy. December 1977.

The Encyclopedia Americana. New York: Americana Corporation, 1959, Vol. 7.

Webster's New Collegiate Dictionary. Ed. Henry Bosley Woolf. Springfield: G. & C. Merriam Comapny, 1973.

Wheeler, Robert R., and Maurine Whited. OIL--From Prospect to Pipeline. Houston: Gulf Publishing Company, 1958.